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Grading Aggregate for Mechanically Compacted Concrete Pipe

Recommends Intermittent Type of Grading — Especially Applicable to Smaller Pipe Sizes Where Percolation Is Factor —Value Proved in Practice

By GEORGE W. GLEESON*

CONCRETE pipe as a material of construction has, by a gradual evolution from an article of questionable merit to one of accepted permanence, attained a rather prominent position in certain lines of construction. This evolution, covering an extended period of time, has been the result of the application of principles discovered in the practice of fabrication rather than from studies such as have characterized plastic concrete. Due, no doubt, to the fact that the concrete used in the manufacture of pipe by the tamped process is of the non-plastic or "dry mix," and due also to the fact that such non-plastic mixes have a limited field of application, an extended study of the numerous variables encountered in this field has never been completed and the literature is almost void of material of particular consequence to the pipe man.

It has been stated that concrete pipe is manufactured entirely upon knowledge gained through experience,[1] and it is realized that this knowledge is somewhat guarded. Such a condition is not one to benefit the industry as a whole; and to the end that certain available knowledge, gained through experience and the application of principle, be disseminated to the industry at large, the following is written.

"Three tests (for pipe) are required—the strength test, the absorption test, and the internal hydrostatic pressure test. The more coarse aggregate used, the greater the strength and the lower the absorption. Unless the grading of the aggregate is carefully worked out and the concrete is mixed for a sufficient length of time, the pipe may fail to meet the percolation (hydrostatic) test because water often percolates through crevices among the coarse aggregates."[2]

Definite Recommendations Lacking

Such statements as the above have been found scattered throughout the literature, but private communication and inquiry have failed to bear fruit in the form of any definite recommendations as to a method of accomplishing the very much desired grading. While the load conditions,[3,4] physical testing,[5,6,7] and hydraulic capacity[8,9,10] have been covered extensively in the literature, far too much descriptive material has been written as regards the art of fabrication of concrete pipe, excluding fundamental data that might promote discussion and in the end provide definite information. Accordingly, the following may be found to be somewhat short of descriptive material, it being the simple purpose to present a definite idea as regards aggregate grading.

Where Percolation Is Leading Problem

The writer long held to the maxims of grading as proposed by Fuller and Thompson[11] with the realization that although not particularly suitable for the smaller pipe sizes, it seemed a logical basis upon which to proceed. Repeated tests have proved the maximum density principles to be misleading as far as the pipe sizes are concerned where percolation offers more of a difficulty than strength. The limiting size for which percolation loses value as a test due to the heavy wall of the larger diameter pipe, may be roughly taken as 15 to 18 in. in the tamped pipe field. It is still considered that maximum density grading, suitably modified to decrease the harshness of mix to some extent, is the solution for strength problems in the large size pipe. Such a type of grading has been most satisfactorily covered in the recent, remarkable discussion by C. C. Furnas.[12] In view of the above, this article may be considered to deal only with those sizes where percolation presents a serious problem.

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[1] Private communication, Portland Cement Association.

[2] M. W. Loving, *Jour.* Amer. Concrete Inst. Vol. 1, No. 7, 1930.

[3] *Bull.* No. 31, Engineering Exp. Sta., Iowa State College.

[4] *Bull.* No. 47, Engineering Exp. Sta., Iowa State College.

[5] *Bull.* No. 22, University of Illinois.

[6] A. S. T. M. Specification C14-24.

[7] Joint Committee Specification.

[8] U. S. D. A. *Bull.* No. 854.

[9] U. S. D. A. *Bull.* No. 906.

[10] U. S. D. A. *Bull.* No. 852.

[11] *Proc.* Amer. Soc. Civil Engr. 33, 222, 1907.

[12] *Ind. & Eng. Chem.* 23, 1052, 1931.

Danger in Excess of Coarse Material

Because of the increase in strength and decrease in absorption with the use of more large size aggregate (increased fineness modulus) many manufacturers have loaded their mix to the maximum extent with coarse material. Danger lies in such practice, for there is a limit to the above generally true condition at which there is insufficient cement paste for complete coverage, as a result of which the harshness that develops gives actual recession in strength. Adherence to the above reference on maximum density grading will eliminate the possibility of carrying the use of coarse material too far. The result will be a more salable product if not a stronger one.

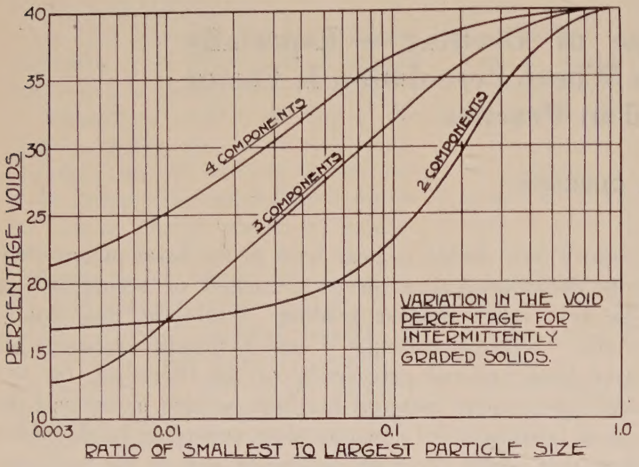

Figure 1

Intermittent Type of Grading

Due to the inherent harshness of maximum density mixes they are not suitable where percolation is a factor, and experiment and experience dictate the use of the intermittent as opposed to the continuous type of grading. The writer believes this article for the first time places in the literature a specific recommendation for use of the intermittent type of grading for concrete pipe mixes. So successful have tests been and so well substantiated the principle that it will be described in some detail, with the understanding that it is for use only in the sizes where percolation through a thin wall section under hydrostatic pressure is imminent.

Bespalow and Zaugg have presented conflicting ideas on the type of grading to resist percolation, and the writer has borrowed from them the idea of a graphic representation of an aggregate by plotting sieve size against percentage retained. J. J. Early presented ideas on the intermittent type of grading in a brochure prepared for the Atlas Portland Cement Co., but it remained for Furnas[12] to define in exact terms the fundamentals of such a system. The writer obtained his first intimation of the usefulness of such a system from a study of the work of Feret.[13]

An intermittently graded aggregate may be defined as one in which there exists a distinct gap between particle sizes as opposed to a uniform variation. Figure 1, taken from the work of Furnas,[12] shows the variation in void space (which is a true measure of resistance to percolation) with change in the ratio of smallest to largest particles in systems composed of 2, 3 and 4 component sizes. It is at once evident that for a ratio greater than 0.01, the two-component system represents the minimum void space. This work has been published since the writer completed some experimental studies on the intermittent type of grading, and it is considered to be a decided substantiation of the results obtained in regard to concrete pipe. Obviously, in dealing with a practical material it is not feasible to obtain separate particle sizes to meet the theoretical conditions, nor is it desirable to do so.[14] It is, however, possible to obtain rather widely separated sizes of aggregate, such as roofing gravel or screened rock as compared to a mason sand, and it was with these materials in mind that previously mentioned experiments were conducted.

Increase in Size Separation Reduces Voids

Table I presents a small part of the data obtained by combining screenings in equal parts and measuring the percentage of void space in the combination. The weighted specific gravities were used in all cases in the calculation of void space from weight, the specific gravities of the separate aggregates being obtained by the Chapman flask. The diameter ratios were calculated from the nominal diameters between sieve openings. The method of com-

TABLE I

Mix* Equal Parts	Percentage of Void Space	Ratio of smallest diameter to largest diameter
	Dry Rodded, ⅜ in. maximum size	
1-1	38.8	1.0000
1-2	37.8	0.5000
1-3	34.7	0.2500
1-4	31.5	0.1250
1-5	26.2	0.0650
1-6	25.9	0.0209
	Dry Loose, ⅜ in. maximum size	
1-1	43.6	1.0000
1-2	42.6	0.5000
1-3	39.2	0.2500
1-4	36.1	0.1250
1-5	32.5	0.0650
1-6	32.1	0.0209
	Flow table, 10 drops per layer for 3 layers, ⅜ in. maximum	
1-1	37.8	1.0000
1-2	35.0	0.5000
1-3	30.8	0.2500
1-4	30.6	0.1250
1-5	29.1	0.0650
1-6	27.7	0.0209
	Dry Rodded, ⅜ in. maximum size	
7-1	37.2	1.0000
7-2	36.6	0.6390
7-3	33.2	0.3200
7-4	30.8	0.1600
7-5	28.8	0.0800
7-6	26.4	0.0410

*1—Through 0.371 on No. 4
2—Through No. 4 on No. 8
3—Through No. 8 on No. 14
4—Through No. 14 on No. 28
5—Through No. 28 on No. 48
6—Through No. 48 on No. 100
7—Through ½ on 0.371

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[12] Loc. cit.

[13] Feret, Ann. ponts. chauss., (7), 4, (5-164) 1892.

[12] Loc. cit.

[14] F. O. Anderegg, private communication.

paction was varied to determine the possible extent to which this might influence the general result.

Figure 2 presents graphically the results of Table I and the indications are quite clear that an increasing separation in component sizes reduces the void space. Practical considerations limit the extent of the separation possible by the fineness of the small aggregate or sand obtainable and this matter was considered in some detail.

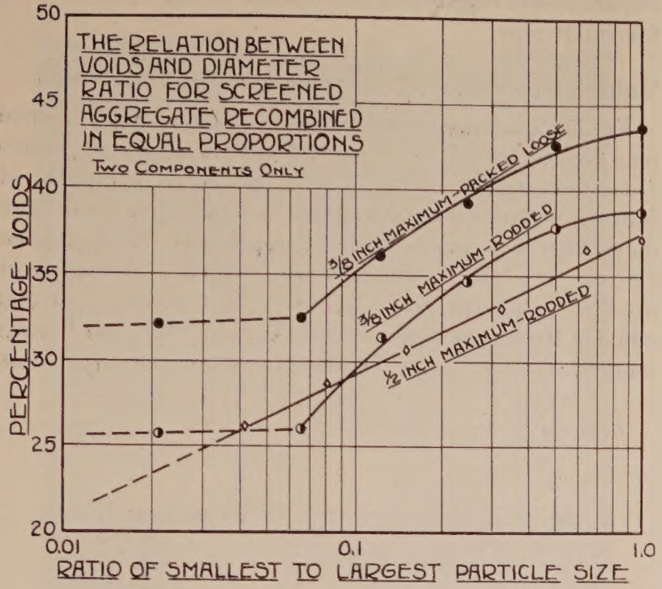

Figure 2

TABLE II

Test Results of Pipe Made With "Two-Peak" Aggregate

2-Day Percolation Test *8-in. and 6-in. diameter pipe*

All samples passed the 20-lb. per sq. in. percolation test without leak. Seven pipes were carried to the following internal pressures in lb. per sq. in., which was the available city water pressure at the time of test: 61, 64, 63, 63, 63. One pipe failed at 63 and one at 51. The above samples had been cured 12 hours and allowed to remain in the curing room 24 hours before test.

15-Day Tests—Percolation

All samples passed the 20-lb. per sq. in. percolation test without leak. Seven samples were tested at the following maximum available city water pressure at the time of test, in lb. per sq. in.: 71, 55, 64, 65, 65, 65, 63. No samples failed under available pressure. The above samples were from the same batch of pipe as the 2-day samples, after being stored in the yard with no special treatment for the intervening period.

Strength

Sample No.	Total Load, Lb.*	Load, Lb. per Ft.**	Required Load, Lb. per Ft.	Per Cent Over Specification
1	4,600	1,310	1,000	31.0
2	4,800	1,370	1,000	37.0
3	4,910	1,400	1,000	40.0
4	4,410	1,260	1,000	26.0
5	4,600	1,310	1,000	31.0
6	4,750	1,360	1,000	36.0

Hot Water Absorption (5-*hour boil*)

Sample No.	Dry Weight	Wet Weight	Increase in Weight	Per Cent Absorption
1	596.0	638.0	42.0	7.05
2	855.0	915.5	60.5	7.07
3	672.0	712.0	40.0	5.95
4	656.0	697.0	41.0	6.25
Cold Water Absorption (24-*hour immersion*)				
1	915.0	976.0	61.0	6.67
2	831.5	887.0	55.5	6.68
3	635.5	675.5	40.0	6.30
4	668.0	712.0	44.0	6.58

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* **Three-edge bearing test, Nos. 1 and 2 with loadometer and Nos. 3, 4, 5, and 6 with Riehle 150,000-lb. testing machine.

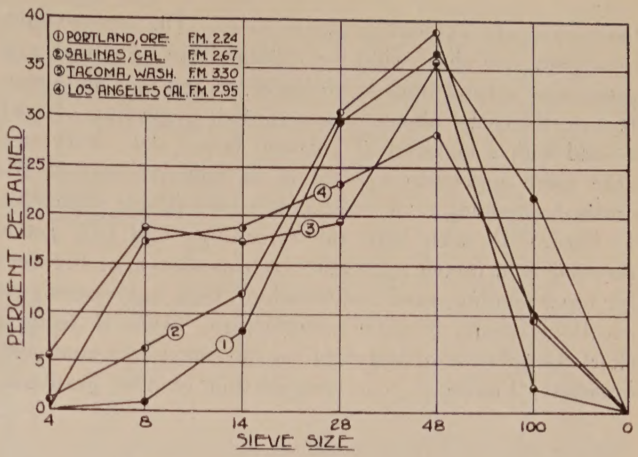

Figure 3

Figure 3 is a graphical representation of the sieve analyses of a number of typical sands. It will be noticed that nature at times approximates the intermittent system, since distinct humps, representing large percentages of

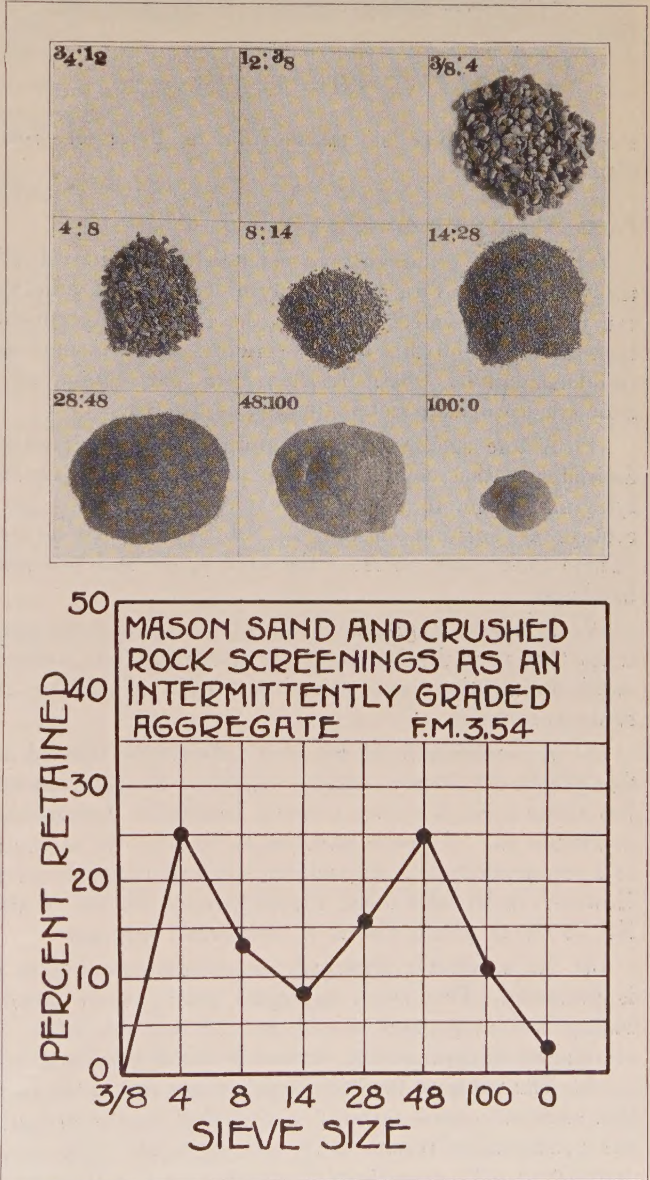

Figure 4

two sizes, are evident in some cases. The approximate minimum size that could be obtained for practical purposes was a sand high in material on the No. 48 screen. It was, then, the object to accomplish a grading of such a sand with a material of uniform larger size. Very suitable large aggregate was found in both pea gravel and crushed screenings. A combination of suitable sand (No. 1, Figure 3) with both the screenings and pea gravel resulted in a mixed aggregate such as shown in Figure 4 for the screenings-sand combination. Both aggregates gave excellent results in pipe manufacture, Table II being a short compilation of test data for the screenings-sand combination. Figure 5 is a cross-section of this particular screenings-sand mix as taken from a piece of 8-in. diameter pipe.

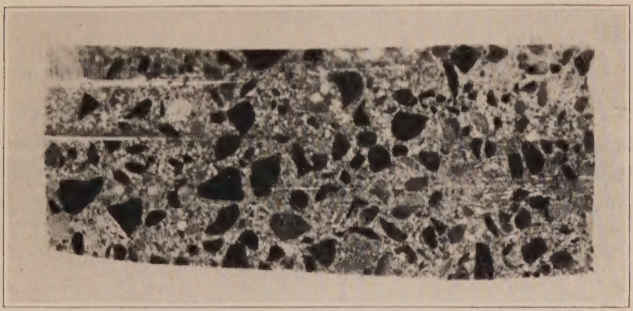

Figure 5

Facts About Intermittent Grading

For the sake of brevity, an extended discussion of all tests involving the use of the intermittent type of grading can not be presented; however, the following pertinent facts in regard to this type of grading are presented as recommendations where resistance to percolation with maintenance of satisfactory quality is desired.

(1) A fine aggregate in the form of durable sand is desired, one that contains a high percentage of material lying on the No. 48 and No. 100 sieves with as low a percentage as possible on the No. 14 and No. 28 sieves. (These latter sizes increase the void space and promote harshness.)

(2) A coarse aggregate in the form of durable particles that pass the limits of the maximum size desired and contain little or no material on the No. 14 and No. 28 sieves is suitable.

(3) A combination of the above should be effected so that practically 50 per cent, by weight, of the combination lies above a No. 8 screen, it being feasible to increase the maximum size of coarse particles to increase the strength as a recommended fineness modulus or experience dictates. However, in all cases a gap should exist on the No. 14 and No. 28 sieves, giving rise to a "two-peak" aggregate.

(4) As a suitable standard for comparison, Figure 6 is presented. This is an aggregate produced by recombining screenings and should be one not incapable of attainment or approach by various practical combinations.

(5) The value of the "two-peak" mixes lies in the facts that sufficient coarse material is included to give strength, the combination results in a low aggregate void space (consistent with experimental evidence and mathematical prediction) to give impermeability, and the proportion of coarse to fine material is such that the absorption test falls below the usual limits. Added to the above characteristics is an increase in workability through the possibility of the addition of more water than is generally incorporated, with the subsequent effect upon production and quality.[15] In fact, all of the characteristics desired and long sought for are bound together in this method of aggregate grading for small pipe.

Value of Intermittent Grading Proved in Practice

Further evidence of the feasibility of the above method may be had by reference to Figure 7, of a pipe aggregate from the southern states that is composed primarily of limestone granules. Here again a "two-peak" mix produces very fine pipe. Figure 8 represents the aggregates for (1) a plant in the northwest which makes pipe of excellent appearance and quality, (2) a Texas plant that adopted the recommendations in August, 1931, and reports marked success, and (3) an aggregate, the pipe from

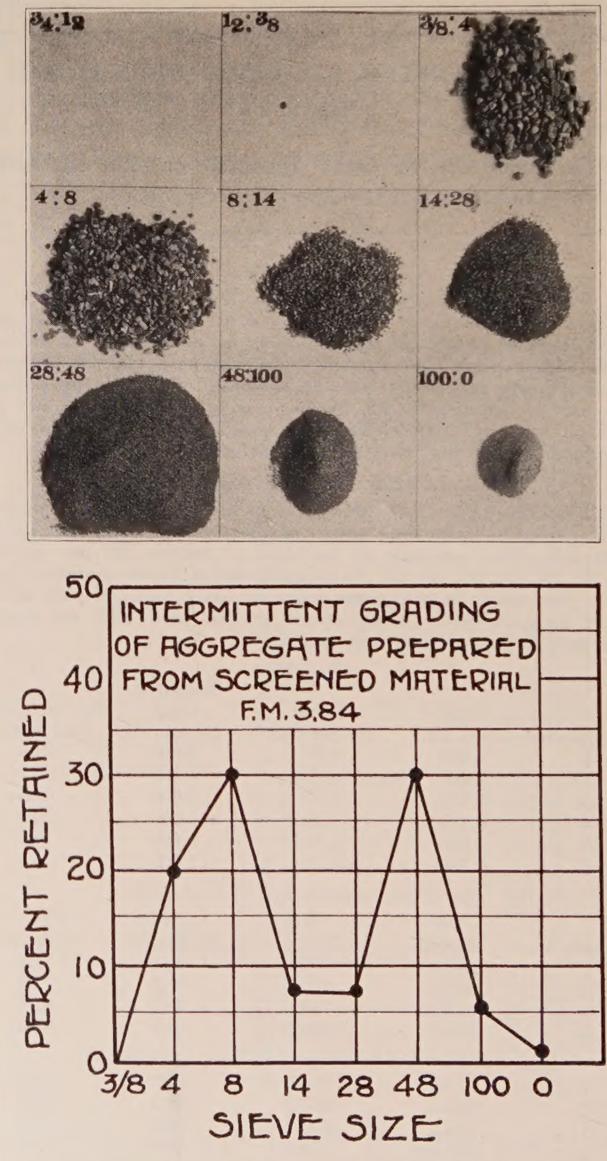

Figure 6

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[15] *Concrete Products,* December, 1929.

which failed to meet the specification, due to percolation. The evident reason is too high intermediate percentages on the No. 14 and No. 28 sieves.

It is fully realized that the foregoing is open to criticism; however, it has been the writer's experience that many different gradings and combinations of material failed to produce the results that the above-described system accomplished. As will be noted in all of the preceding figures and data the work has been carried on with a maximum size material of ⅜ in. This means small pipe, and was so intended, because the most severe conditions are imposed on the 8 and 10-in. pipe. Solution of the most obvious difficulties was attempted first. However, as the pipe size increases the possibility of using a larger size coarse aggregate is increased, the maximum limits being set by the ratio of surface area to volume or "boundary" conditions for the particular size.

Although the foregoing material departs rather radically from the more general practice, it is presented with the knowledge that a small number of plants have profited by its use. The writer sincerely invites comment or criticism, because it is felt that a more certain knowledge of production operations is necessary for the concrete pipe industry to continue in its development. Aggregate grading is unquestionably necessary, but information as to methods is sadly lacking, and it is hoped that this brief summary of one method that has been successful may promote developments or discussion that will be constructive.

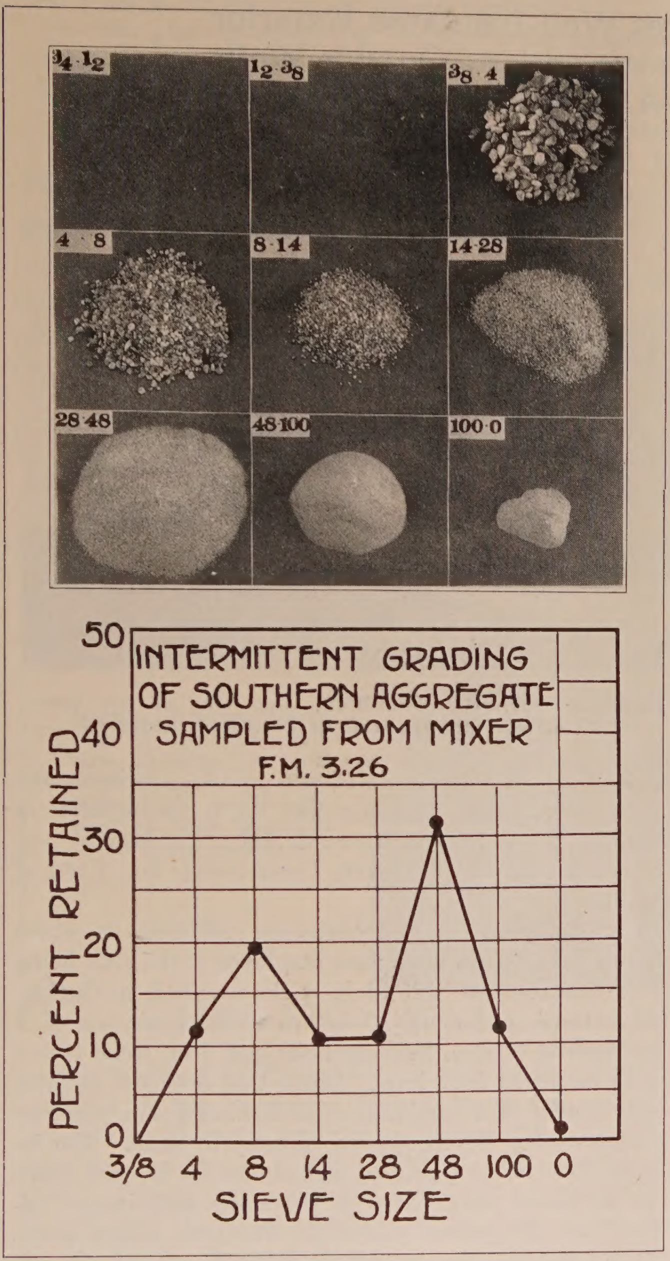


Figure 7

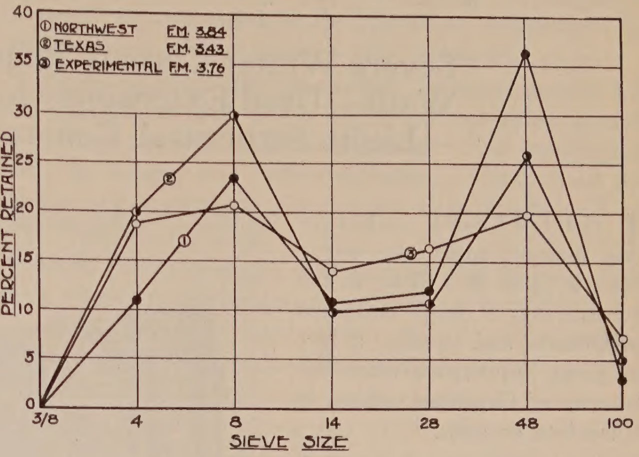


Figure 8

Road Builders' President Urges Highway Building With Tax Funds

The number of motor vehicles has increased 40 per cent in the past five years, while the amount of road building has shown a growth of only 13 per cent, according to W. R. Smith, president of the American Road Builders' Association. He believes the need for making up the deficiency in highways is urgent both from the standpoint of economy of travel and safety on the public roads.

"In spite of the logic and fairness of using motor vehicle taxes exclusively for roads essential to the use of motor vehicles, efforts are being made to injure highway transportation by the diversion of motor vehicle taxes to other purposes," he continued. "The breaking down in highway transportation that is sure to follow any such policy of diversion will probably add from $20 to $75 a year additional cost for each owner in motor vehicle upkeep and operation—equivalent to a large increase of taxes to 26,000,000 motor vehicle owners instead of a decrease. It is a case of 'saving at the spigot and losing at the bung hole.'"

Government Engineers Take Concrete Course

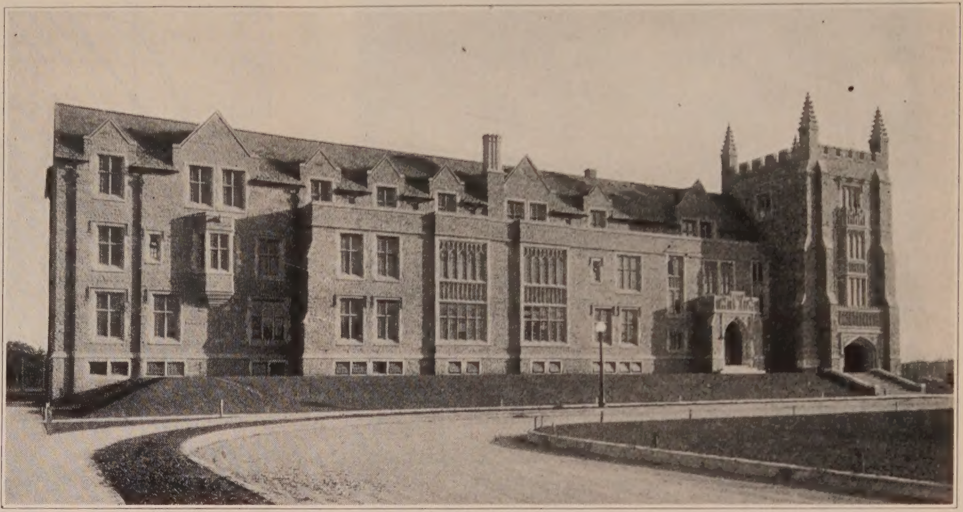
Forty-three engineers representing seven offices of the United States Army Engineers Corps attended a course in field control of concrete conducted in the Portland Cement Association laboratory, Chicago, May 2 to 7.

This is the fifth consecutive year that the course has been held for engineers in charge of flood control and navigation construction projects on the Mississippi and its tributaries.

Insulation With Light-Weight Units Appeals to Canadian Architects

Severe Winter Climate Requires Well-Insulated Exterior Walls—Used Extensively in Partitions and Outside Walls—Light Structural Concrete Also Winning Acceptance

LIGHT-WEIGHT concrete masonry units have won a definite place as a factor in the construction of large buildings in Ontario and Quebec, a fact of great importance when the severity of Canadian winters is taken into account.



Administration building, McMaster University, Hamilton, Ont. One of five new buildings having light-weight concrete units in wall back-up and partitions

Accepted Because of Insulating Value

The general use of light-weight concrete units in eastern Canada may be said to date from the installation of several plants for the production of light-weight aggregates several years ago. One of these is the haydite manufacturing plant installed by the Cooksville Company, at their brick manufacturing plant near Toronto.

The acceptance, by architects, of light-weight concrete units made from these new aggregates was due in no small degree to the insulating value of the units. The severe climatic conditions comprised one of the strongest points in their favor, and their light weight made it possible to use them in locations where dead weight is important.

Beaconsfield Golf Club building, in Quebec, has 12-inch exterior walls of light-weight concrete units, coated with stucco

Some Notable Buildings Utilizing Concrete Units

Among the buildings in which light-weight units were employed, five new structures for McMaster University, at Hamilton, Ontario, are outstanding examples. The administration building, one of the five, is shown in an illustration. All of the buildings have haydite units for backing up all exterior walls, and in all partitions. The architects of these buildings are W. L. Somerville, of Toronto, and J. Francis Brown & Son. The general contract was held by the Pigott Construction Co., Ltd., of Hamilton.

Another attractive and high-class building in which similar light-weight units were employed is the club house of the Beaconsfield Golf Club, at Beaconsfield, in Quebec. The exterior walls are 12 inches thick, made up of a combination of 8-in. back-up units and 4-in. stone facing up to the main floor level. Above that level the exterior walls consist of a combination of 8-in. and 4-in. concrete units, with the stucco applied directly to them. The interior, likewise, is plastered directly to the haydite units. The architects were Barott & Blackader and Hugh Vallance, and the general contractor was John Baxter & Co.

The Glen Eagle apartment building, illustrated on page 13 of the February (1931) issue of CONCRETE, is one of the best appointed apartment structures in Montreal. In this building, as in the ones mentioned previously, the partitions and exterior wall back-up units are of haydite concrete, and their insulating value was mainly responsible for their selection. The architects of the Glen Eagle apartment building were Ross & MacDonald, of Montreal, and the general contractor was the Dakin Construction Co., of the same city.

Light-Weight Structural Concrete Also Favored

This light-weight aggregate is also being used structurally in Canada. A notable example is the Northern Vocational School, in Toronto, in which this light material was used for the structural concrete throughout, in the structural frame and floors. Because of the rather long spans over class rooms and laboratories, the lighter weight of this material is an important factor in holding down the dead load stresses. C. E. C. Dyson, architect for the Board of Education, designed this school building, and Wilde & Brydon were the general contractors.

Another plant established in Toronto for the production of light-weight aggregate is the concrete plant built by the Toronto Brick Company. The prepared cinders produced are utilized by the brick company in the manufacture of light-weight concrete units, especially for back-up and partition work, and for sound deadening.

Three Adjoining Buildings Use Concrete Units

A notable group of three buildings occupying adjoining lots on University Avenue, Toronto, all built in 1929, utilize 12-in. and 8-in. cincrete units in backing up exterior walls, and partition units in addition. These three buildings are shown in one of the illustrations.

One of the three buildings just mentioned is the home of the University Club of Toronto. Mathers & Haldenby were the architects, and the Jackson Lewis Co. held the general contract. The central building of the group is occupied by the Provincial Pulp & Paper Co., and was designed by Marani & Lawson, architects. Witchall & Son were the contractors. This building was awarded the medal of honor at an exhibit of the Ontario Architects' Association. The third building, on the right, is occupied by the Abitibi Power & Paper Co., and it was also designed by Marani & Lawson, architects. The general contract was held by the George A. Fuller Co., Ltd.

Group of three buildings in University Avenue, Toronto, all built in same year, in which light-weight concrete back-up and partition units were employed

The high standing of the Canadian architects who are specifying light-weight concrete building units is in itself a matter of gratification to the concrete building industry. This fact demonstrates that these products have won definite recognition as a high-class building material.

Should Exhibit Concrete Industry at World's Fair

Actual Manufacturing or Operating Processes Considered Best Form of Display

The Century of Progress Exposition to be held in Chicago from June 1 to November 1, 1933, has as its principal object the portrayal of the manner in which industry has utilized inventions and scientific discoveries for the improvement of living conditions during the past century.

Wherever exhibits can be shown in the actual process of manufacturing a product, that form of display is urgently recommended by the exposition authorities. Exhibitors may sell the products thus produced.

Water, sewerage and alternating current electricity will be available at most points within the exposition grounds by comparatively short connections. Gas connections will be longer, and rather expensive. Compressed air, steam and mechanical connections from shafts will not be available.

From the foregoing it will be seen that full-size, half-size or quarter-size plants for the actual manufacture of products such as portland cement, light-weight aggregates, concrete pipe, concrete building units and related products could be shown. The construction of concrete houses and concrete highways in various stages, the operation of central concrete mixing plants and transit mixers, and the use of special concrete forms, could also be displayed in realistic fashion.

Exhibit spaces will, in general, be in units 20 ft. square, or in a number of such units. The rental charge for the duration of the exposition will be at the basic rate of $10 per sq. ft. for space within the general exhibit buildings erected at the expense of the Century of Progress, and $2.50 per sq. ft. for outdoor open exhibit space.

Expiration Dates for Receipt of Applications

Applications for outdoor exhibit space not involving the construction of buildings or outdoor structures or works will be received up to December 31, 1932.

Applications for space in any of the general exhibit buildings must be made not later than July 1, 1932, where the exhibit installation requires special foundations; or September 1, 1932, where the exhibit requires special connections for water, sewerage, electricity or other utilities; or November 1, 1932, for all other exhibits.

Applications for exhibit space shall be made out in triplicate, on forms obtained by addressing Major Wayne O. Axtell, in charge of the mineral industries section, Century of Progress, Administration Building, Burnham Park, Chicago, Ill.

Co-ordination of Basic Principles of Concrete Mixtures

Second Article Defines Absolute Volume and Supplies Formulas for Calculation of Data Needed—Practical Application to Design of Mixtures

II—Absolute Volume, the Basic Measure of Ingredients (Concluded)

By JOSEPH A. KITTS
Consulting Concrete Technologist, San Francisco, Calif.

(*Continued from May Issue*)

THE previous article pointed out that the bulk volume measure, commonly used as the basis of proportions, is the rudimentary measure used by the ancient makers of concrete and is a heritage which has reacted as a barrier to modern scientific thought in the study of the physics of concrete mixtures. It has reacted to delay general recognition of absolute volume as the practical and scientific basis of measure of the ingredients. From generation to generation, down the ages, concrete workers, both practical and technical, have passed on the ancient lore that concrete is made with one basket, bag, shovel or barrow of cementing material to two of sand and four of rock.

Where Both Practice and Science Have Failed

This bulk volume measure, varying from 0.5 to 0.9 in absolute volume of aggregate solids and involving an error of 50 to 10 per cent in the absolute volume measure, has contributed to partial failure in both concrete making and concrete research. Concrete making has been a haphazard, rule-of-thumb, cut-and-try, inexact and rudimentary process, not an exact and scientific one, primarily because of the bulk volume basis of measure.

Practical methods of concrete making have been neither sufficiently practical nor scientific enough to insure reliability. Scientific methods have been neither sufficiently scientific nor practical. The best interests of the concrete industry are served only by facing these shortcomings; and the answer to the arguments of such men as Dr. George F. Swain can be found only in a co-ordination of present knowledge of concrete mixtures, an augmentation of that knowledge, and the scientific control of concrete production in accordance with that knowledge. Appreciation of absolute volume as the basic measure of ingredients is the first essential in this scientific method of production.

Having become accustomed to the conception of concrete proportions in bulk measure, it is very difficult at first to think in terms of the absolute volume. In order to utilize, practically, the absolute volume basis of measure in the most simple and direct manner it is necessary to adopt corresponding standards of measure of the physical characteristics of aggregates, cement and dry admixtures, departing, with one exception, from the present American standards. Absolute volume will be defined and an outline of aggregate tests will then be given to clarify the use of the absolute volume basis.

Definition of Absolute Volume

"Absolute volume" is used here in the practical sense (not the precise) to mean the volume displaced by the solids. It is the total volume within the surfaces of the particles in the case of solids (aggregates, cement and solid admixtures), and the volume, at usable temperatures, of water and liquid admixtures. It is generally called "apparent volume" by concrete physicists, as it includes the microscopic pores within the particles. It is the volume on which the standard "apparent specific gravity" of cement is based. One standard bulk cubic foot or 94 lb. of cement, having an apparent specific gravity of 3.11, contains $94/(3.11 \times 62.4)$ or 0.485 cu. ft. absolute volume, in which the weight of a cubic foot of water is taken as 62.4 lb. One cubic centimeter of absolute volume of this cement weighs 3.11 grams, and the bulk volume may vary from 1.7 to 2.5 c.c., depending on the compactness.

Characteristics of Aggregates for Absolute Volume Basis

Determination of the physical characteristics of aggregates, essential to the employment of the absolute volume basis of measure, involves very simple tests with readily available apparatus. A practical test example will serve to show the new basis of "density," "moisture content," "absorption," "weight per unit volume," "bulking," and "apparent specific gravity." For brevity, only two means of measuring will be assumed—weight and bulk volume—for aggregate with natural moisture content in excess of absorption. Appropriate to the general subject, the tests will be co-ordinated into one procedure.

Weight-Volumetric Tests for Density, Bulking, Specific Gravity, Moisture, Absorption, etc.

Apparatus:

Bucket and Scales.

Tests:	*Example*
A.—Weigh water, exactly filling bucket	24.96 lb.
B.—Weigh loose-moist aggregate, filling bucket	35.47 lb.
The manner of filling the bucket should simulate the practical operation of loose	

bulk volume measure that it represents, such as shoveling into a barrow. The excess material should be struck off even with the top of the bucket without compacting.

C.—Surface dry B, and weigh .... 33.93 lb.
D.—Dry C to constant weight and weigh .... 33.29 lb.
E.—Weigh D inundated, exactly filling bucket with water .... 45.49 lb.

An amount of water nearly equal to the proportion of voids should first be put into the bucket and then the material D added quickly, but in such manner as to prevent trapping of air, then placed on the scales and quickly filled with water to minimize time of absorption.

Calculations:

d = loose-moist density = $[A-(E-D)]/A$ .... (1)
= proportion of absolute volume in the bulk measure
= $(24.96 - 45.49 + 33.29)/24.96 = 0.511$

$1.0-d$ = voids in the bulk measure = 0.489 .... (2)

b = bulking of the absolute volume by voids = $1.0/d$ .... (3)
= loose-moist bulk volume corresponding to a unit absolute volume,
= $1/0.511 = 1.957$ = loose-moist measure for unit absolute volume.

g = apparent specific gravity = D/Ad .... (4)
= ratio of weight of dry aggregate to weight of water displaced by it
= $33.29/(24.96 \times 0.511) = 2.61$

a = absorption by the absolute volume = $(C-D)/Ad$ .... (5)
= $(33.93 - 33.29)/(24.96 \times 0.511) = 0.051$

m = moisture content = $(B - D)/Ad$ .... (6)
= volume of moisture to unit absolute volume of aggregate
= $(35.47 - 33.29)/(24.96 \times 0.511) = 0.171$

m' = free moisture = $m - a$ .... (7)
= $0.171 - 0.051 = 0.12$

w = weight of moist aggregate for 1 cu. ft. absolute volume of aggregate $= 62.4(g+m)$ .. (8)
= $62.4(2.61 + 0.171) = 173.53$

Application:

Having determined the absolute volume proportions of aggregate in the mix, the bulk volume measure is determined by equation (3) and the corresponding weight measure by equation (8).

The correction for free moisture in a unit volume of the particular aggregate is made by equation (7).

This is all fundamental and practical physics, and its logic is soon recognized with a little study and use. A clear understanding of these basic measures is essential to a knowledge of concrete physics.

The practical application in mixture formulation is shown completely in the November and December (1931) issues of CONCRETE.

Recognition of the Absolute Volume Measure in Concrete Physics

A modicum of appreciation of the absolute volume as the basic measure is noted throughout the literature on concrete, although its practical importance has been obscured by the bulk volume conception of proportions.

Determination of the specific gravity of the absolute volume of cement and aggregate is no doubt as old as the specific gravity definition itself. The cubic centimeter graduate and metric scales constitute the first specific gravity apparatus. Specific gravity flasks and bottles were made for the testing of cement by Schumann, Stanger and Blount, Keat, Le Chatelier and others, prior to 1904. However, it is noted that weight of cement per unit bulk volume was a common specification in England at this time. Charles F. Marsh, in his book on "Reinforced Concrete" (1904), states: "The test most generally adopted in this country [England] is that of the weight per striked bushel. The specific gravity is, however, a far better and surer indication. . . . The manner of filling the bushel measure greatly influences the weight, while by taking the specific gravity there is no chance for error if ordinary care is exercised. It is impossible to obtain a heavy weight per bushel with a finely ground cement. . . . The finer the cement the lighter it will be, as there will be more air in the interstices."

The Work of Feret

That there are voids or interstices in the bulk measures of aggregate and cement has long been recognized, and some of the older theories of proportioning are based on filling the voids in coarse aggregate with fine aggregate and the voids in the fine aggregate with cement—the voids theories.

Feret's research, prior to 1897, employing the absolute volume as the basic measure, has been mentioned. By this means Feret discovered many, if not most, of the known fundamentals of mixtures, including that most fundamental law of mixtures, namely, that the ingredients fit together as absolute volumes.

Talbot and Richart's Conclusions

Talbot and Richart, prior to 1923, employed the absolute volume method of Feret (see University of Illinois Bulletin No. 137, October 15, 1923). Their tests (Series 2G) of 113 mixtures, varying from very fine sand mortar to 2-in. maximum aggregate concrete, show that the ingredients fit together as absolute volumes. The authors state in their conclusion: "The use of the absolute volume of the materials gives simple and convenient methods of analysis and calculation, and in many ways is advantageous. To think in terms of the absolute volume of the materials in a unit volume of mortar or concrete itself gives an advantage in making comparisons and judging effects. When the density of the material as it is found by the method of measurement to be used on the work is known, the volumes by bulk measurement may easily be obtained." (See Equation 3.) "The advantage of measuring aggregates by weight, in producing concrete of uniform quality, is apparent. Since the specific gravity of sands in a given locality varies but little, the use of the average specific gravity is sufficiently accurate for most purposes."

Walker's Yield of Concrete

Stanton Walker, in "Estimating Quantities of Materials for Concrete" (Bulletin 1, National Sand and Gravel Association, September, 1926), uses the sum of the absolute volumes of aggregates, cement and water as the yield of concrete.

The Portland Cement Association, in "Design and Control of Concrete Mixtures," Second Edition, January, 1927, states: "The quantities of materials in a concrete mixture may be accurately determined from the fact that the volume of concrete produced by any combination of materials, so long as the concrete is plastic, is equal to the absolute volume of the cement plus the absolute volume of the aggregate plus the volume of water." Further, with reference to the fineness modulus (grading) of the mixed aggregate, this publication states: "For average aggregates the percentages may be calculated by weight. The fineness modulus is, however, based on absolute volumes, and in determining the fineness modulus of a mixture of two or more aggregates having a large difference in specific gravity these factors must be taken into account."

The foregoing would appear to be ample evidence that the absolute volume is the basic measure of ingredients for concrete mixtures.

Applicable to Many Types of Specifications

The writer and his associates have employed the absolute volume basis of proportions since 1924, on several million cubic yards of production, including, since 1926, ready-mixed concretes for every purpose of a metropolitan center; for job methods of measuring aggregates by loose-moist and inundated bulk volume and by weight; for specified strength, maximum size, and slump, maximum density, water-cement ratio, cement content, fineness modulus, Fuller grading, Talbot grading, arbitrary proportions, and about every conceivable type of specification of the buyer of concrete; and for various types of cements, aggregates and admixtures. Convinced at first that it was the scientific basis of measure, we soon learned that it was the most practical basis of proportioning. It simplified the entire physics and technology of concrete mixtures and made it possible to co-ordinate the fundamentals of the various fragmentary theories of proportioning. It made it possible to discover new laws of mixtures essential to the practical application and clarification of those already known.

The laws of the cement content will be considered in the next article.

Portland Cement Mortars Not Benefited by Sugar

Portland cement mortar is harmed, not benefited, by the addition of sugar, the author of an American Chemical Society convention report stated recently in refutation of erroneous newspaper statements claiming increases in tensile strengths of all mortars.

Gerald J. Cox, co-author of the report, states: "The description of our work and our recommendations apply only to lime-sand mortar. Our search of the literature has revealed about 70 reports on the effect of the addition of sugar to portland cement. The authors are unanimous in their findings that cane sugar ruins concrete made from portland cement and must not be used."

Through an Associated Press release, considerable publicity was recently given to the increase in tensile strength of lime-mortar briquettes by the addition of sugar to the mixing water. The basis for this was a report by Mr. Cox and John Metschl, of the Sugar Fellowship, Mellon Institute of Industrial Research, presented at the April (1932) American Chemical Society convention in New Orleans.

How Bulk Cement Is Handled On Large Building Project

More general use of bulk cement in extensive building projects may result from the experience now being gained in the construction of the new Union Inland Terminal of the Port of New York Authority.

Owing to the size of this undertaking, many unusual problems have developed leading to the adoption of new methods. The handling of cement alone was of particular concern as it involved the transportation, receipt and dry storage at the site of 160,000 barrels. The results have been watched with considerable interest by contractors and others identified with large scale construction.

The terminal, which covers the entire block bounded by Eighth and Ninth avenues, West Fifteenth and Sixteenth streets, Manhattan, will be sixteen stories high and will have a floor area of 2,400,000 sq. ft. Its volume of 37,600,000 cu. ft. will surpass all other structures in the city.

A plan for the handling of cement in bulk was worked out by the general contractor, the Turner Construction Company, in co-operation with the Penn-Dixie Cement Corporation, the Lackawanna Railroad, and the Port Authority engineers. The outcome has been thoroughly successful. The dust nuisance is eliminated, costs are less and concrete is produced satisfying the rigorous specifications.

Bulk cement cars shipped from the cement mill are floated from Hoboken to the unloading plant at the foot of West Twenty-eighth street. Here waterproof and dust-proof connections are made to the discharge hoppers on the cars and the cement is fed by a screw conveyor into a steel storage bin of about 500-lb. capacity.

Trucks with specially designed dust and waterproof steel bodies and roofs receive the cement from the bins by gravity through a hatchway in the roof of the truck. A vent from the truck body is piped into the cement bin during the loading operation so that there is no dust or loss of cement flour. These trucks, with a capacity of 55 barrels of cement, have self-cleaning bodies so that cement may be discharged from a spigot at the rear of the truck.

When a truckload arrives at the building it is driven into either one of the driveways and discharges its load through a canvas boot or tube attached to the spigot into a hatchway in the floor of the driveway connected with a 500-bbl. steel bin. The discharge screw in the truck is driven by the main motor of the truck at a speed sufficient to discharge the contents in about 5 minutes. From this bin the cement is elevated to a 280-bbl. bin located over the mixing plant.

Below the cement operating bin is located an automatic cement meter which determines and gives the owner's representative control of the exact amount which is to go into each batch of concrete. The storage capacity of the several cement bins totals 2,060 barrels. The shipment of cars from the mill is so scheduled as always to insure an ample supply of cement.

Smooth Finish on Exposed Concrete Obtained with Plywood

Exterior and Interior Surfaces Untreated After Forms Are Removed—Cut Sheets to Detailed Dimensions—Assembly of Wall and Form Panels

A NOTABLE development of recent years in concrete form work is the increasing tendency to get away from the use of ordinary lumber, by employing materials especially manufactured or assembled for the purpose.

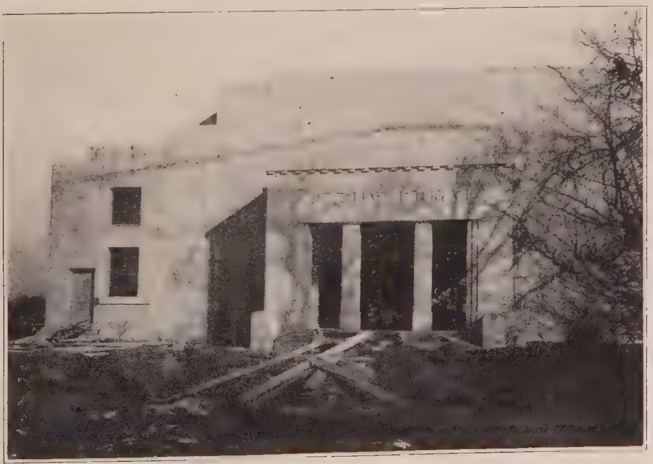
The Elimination of Plaster

Along with the development of special form materials another tendency is clearly observed—the tendency to utilize the concrete surfaces obtained from these special materials as the finished surface, either exterior or interior. In many instances, as in the case of the new medical building for Marquette University,[1] the concrete surface thus obtained forms part of the interior wall or ceiling finish without further treatment. In other instances the surface left by the forms may be stained or given some decorative paint finish. In either event interior plastering, long an important item of cost in building construction, is eliminated.

Notable Building Finished in Concrete

The newly constructed building for pachyderms, in the new Chicago Zoological Park at Brookfield, a western suburb of Chicago, provides a good example of the smooth and clean-cut appearance of concrete surfaces formed with plywood, one of the special form materials being employed in constantly increasing amount.

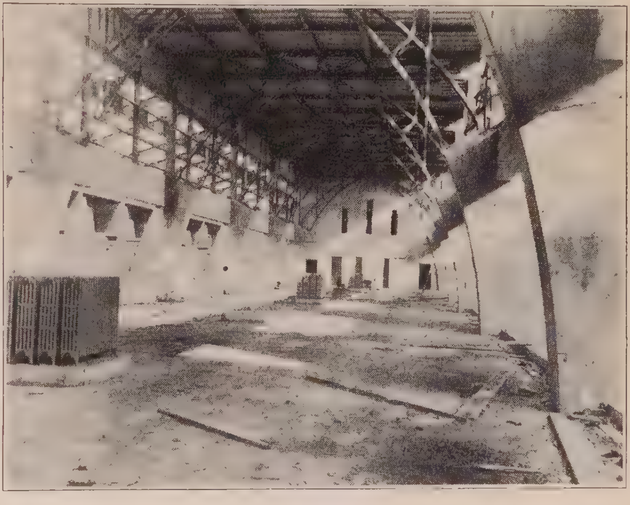
This building, popularly known as the elephant house, is of reinforced concrete construction throughout, and both the exterior and the interior surfaces are being left exactly as they appeared when the plywood forms were removed, without rubbing or any other kind of treatment. The building is of extremely sturdy appearance, in keeping with its future occupants, elephants and rhinoceroses. A companion building, of similar construction, will be occupied by hippopotami and tapirs, other well known members of the pachyderm family.



West entrance of elephant house, in Chicago Zoological Park. The entire exterior is exposed concrete work, the surface being left untouched after plywood forms are removed

Plywood as Structural Form Material

The form material used in this work consisted of sheets of 5-ply Douglas fir plywood 9/16 in. thick, and supplied in sheets 8 ft. long and 2, 2½, 3 and 4 ft. wide. This material was used structurally (not merely as lining) as the sheathing material, reinforced by 2-by-4 and 2-by-6 studding and joists, and the usual horizontal walers. In a word, the plywood not only took the place of the matched and dressed form boards commonly used in ordinary wooden form construction, but it doubtless eliminated much costly rubbing down of board marks.



Smooth and clean-cut appearance of structural concrete in interior of elephant house is due to use of plywood forms

The smooth surfaces obtained in the concrete work through the use of these sheets of plywood are shown clearly in the exterior and interior views of the elephant house.

A typical arrangement of wall forms is shown in the line drawing, where 3-ft. by 8-ft. plywood panels are used. It has been found most satisfactory to place the panels with the length running at right angles with the studding. This detail shows the usual arrangement of studding and walers, the plywood sheets being used as sheathing.

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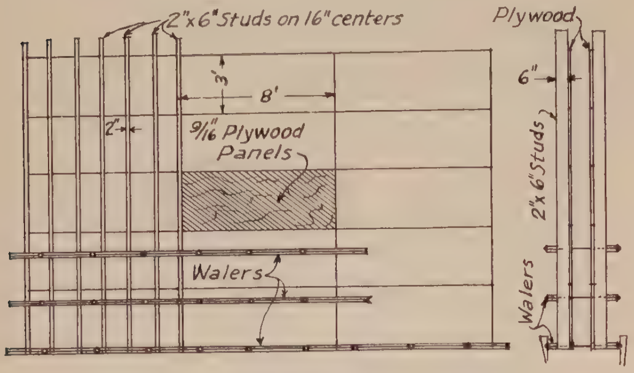
[1] See April (1932) issue of CONCRETE, page 15.

Assembly of Wall and Floor Forms

The assembly of wall forms was greatly speeded up by the use of the large plywood sheets, with each sheet covering many square feet of wall area. One can readily appreciate the advantages gained, in speed of assembly and in smoothness of finish, in having these large sheets to deal with. Form marks occurred only at the vertical lines where the plywood sheets were butt-jointed.



Typical details of plywood wall form panels

Form work for the reinforced concrete floor and ceiling slabs in the elephant house was assembled in the usual way, with floor joists spaced on 20-in. centers and sheets of 9/16-in. plywood laid directly on the joists.

All plywood sheets were treated at the mill with paraffin on both sides and all edges.

Detailing and Cutting the Sheets

Form work details were prepared in advance on this work, and the dimensions of all plywood sheets required were tabulated. From these tabulations it was possible to cut the sheets to the proper dimensions at the manufacturer's plant, thereby reducing job form labor to the minimum.

To meet any unexpected need for cutting the material on the construction work, an electrically driven (but hand-operated) power saw was available.

Manufacture of Plywood

The concrete construction industry will be interested in the essential steps in the manufacture of plywood sheets of the size employed in this work. The logs are cut to various lengths ranging from 6 to 16 ft. and are then rotary-cut in large power lathes. Before the rotary cutting the logs are boiled to softness, somewhat as in paper manufacture. In the rotary cutting operation the thin sheets that are to form the individual laminations of the plywood are peeled off by a sharp knife, in a manner that has the appearance of the unrolling of a roll of paper. These sheets are then cut to the proper widths and lengths, are dried mechanically, after which the finished plywood is made by cementing together, with water-resisting glue, an odd number of layers. The grain of alternate layers is reversed, thereby preventing splitting and minimizing any tendency toward warping.

Acknowledgments

The plywood used on this work is a Douglas fir product. It is manufactured by the Harbor Plywood Corp., of Chicago, and sold under the trade name of "plycrete." The general contract for the building, which is rapidly approaching completion, is held by the W. E. O'Neil Construction Co., and the architect is Edwin H. Clark, of Chicago.

Papers on Aggregates, Volume Changes and Capping Methods in A. S. T. M. Sessions

The thirty-fifth annual meeting of the American Society for Testing Materials will be held at Atlantic City, New Jersey, June 20 to 24.

The session on concrete is the fourteenth scheduled, and will be held simultaneously with the thirteenth, on the afternoon of Friday, June 24. It will open with the report of Committee C-9 on Concrete and Concrete Aggregates, of which Cloyd M. Chapman is chairman. The report will submit revisions of standard methods for organic impurities and sieve analysis of aggregates and methods of making and testing compression test specimens.

Informal reports of the Society's representatives on the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete will follow. Inge Lyse will next present data on tests on consistency and strength of concrete having a constant water content.

"Volume Changes of an Early-Strength Concrete" is to be the subject of a paper prepared by E. R. Dawley, discussing the effect on the volume change of concrete of certain variables.

One of the concluding papers of the session will be that on "Relative Merits of Various Materials Used in Capping Concrete Specimens," by M. V. Nardiello.

Concrete Road Building Progress in Britain

A report on concrete road construction, which has just been issued by the British Portland Cement Association, shows that the mileage of concrete road, equivalent to a 20-ft. width, laid in the British Isles last year, was 445, bringing the total for six years up to 1,540 miles. It is further stated that there was an increase in the 1931 mileage over that of 1930 of nearly 50 per cent.

The longest concrete road in the British Isles is the Ballymena-Antrim road, which is 17 miles in length. The London borough of Southwark began laying concrete roads in 1918 and has now over 22 miles of the type. The materials used in the construction of concrete-surfaced roads in the British Isles in 1931 included 292,000 tons of cement, 1,302,000 cubic yards of stone and sand, and 18,580 tons of steel.

~ ~ Personal ~ ~

J. W. Kelly, concrete specialist in the engineering experiment station at Purdue University, has been appointed to the staff of the engineering materials laboratory of the University of California. Mr. Kelly's work will be under the direction of Raymond E. Davis, professor of civil engineering, University of California.

EDITORIAL

The Gasoline Tax Becomes Easy Money

"AN effort seems to be developing to make the 26 million motor vehicle owners in the United States bear the brunt of unemployment relief," is a statement recently attributed to W. R. Smith, president of the American Road Builders' Association.

Although governors and state legislators seem to have come to the realization that the diversion of funds raised through the original gasoline tax laws may be illegal, as well as unfair to motorists, much gasoline tax money is still being diverted—Mr. Smith estimates the diversion at six per cent of the total. The question of legality, however, has at least served as a temporary check on the scramble for this "easy" money.

But a new danger has now raised its head—the creation of new state laws and city ordinances imposing additional taxes on gasoline for purposes in no way related to the construction of state and county roads or city streets. The danger here lies in the temptation to increase this "easy" tax to a point where a tax revolt will be the inevitable result.

Several states already have made large appropriations out of their gasoline tax funds for unemployment relief, forgetting that highway construction in itself would constitute one of the best and most widely distributed forms of relief. Seven or eight large states are considering the imposition of additional gasoline taxes, the added income to be used solely for unemployment relief. In one state the gasoline tax has been doubled for this purpose, while still another state has provided school funds by similar means.

Other uses of the motorist's money are found in the erection of state buildings, conservation of oysters, propagation of fish, the purchase of a watershed, and payment of salaries of miscellaneous state officials.

In the hands of smaller units of government the abuse of the gasoline tax is even more glaring. In one state alone six counties and more than a hundred cities and towns collect a gasoline tax in addition to the state tax. In one of these cities a part of this tax was used to build a municipal bathing beach.

In addition to all this, there is a probability that a special gasoline tax will be included in the tax bill to be passed by Congress. Evidently the sight of this easy gasoline money is too much for our legislators, regardless of whether they represent national, state or city governments.

Several national organizations, among them the American Road Builders' Association and the Portland Cement Association, are engaged in a fight to check this vicious tendency to impose taxes on gasoline for all manner of purposes. It will be a hard fight, for it must be waged against a great number of separate governmental units. Only through coordination of effort can the fight be wholly successful.

Putting Cement and Concrete on Exhibition

RECENT inquiry by a representative of "Concrete" disclosed that up to the present moment only a few companies representing the cement and concrete industry have contracted for exhibit space in the Century of Progress Exposition to be held in Chicago in 1933.

Several additional organizations in this industry are considering the taking of space, but the number is not impressive.

Granting that there is justification for thinking twice before assuming the expense involved, the fact remains that all industries are in a similar situation in this respect. It would be most unfortunate if, in this great display of the uses which industry is making of scientific discoveries and inventions, it should turn out that cement and concrete and the products made from them are inadequately represented.

The manufacture of light-weight aggregates, the manufacture of concrete building units and concrete pipe, the construction of concrete roads and houses, the manufacture of cement itself, are just a few of the ways in which this industry could be popularized as a result of exhibits at the 1933 world's fair.

Why Paved Roads Are Necessities

BATH tubs and electric lights once were regarded as luxuries. Less than two decades ago motor vehicles were luxuries; now they, too, have become necessities.

Consider the thousands of mechanics who live in the country and drive many miles to work; the contractor who drives from job to job; the salesman whose motor car is his transportation. Consider the new transportation facilities developed by the bus lines and motor transport companies.

Ever since motor vehicles advanced to the status of necessities, the roads on which they operate have been necessities, for the motor vehicle is useless without good roads. That is why paved roads have become necessities to a large part of our population.

Curtailment in this phase of our country's development constitutes false economy in one of its worst forms.

PROGRESS—In a Page

Current activities in research, in matters pertaining to concrete and cement, as being carried on or completed by various organized groups.

A. S. T. M. Purchase Specification for Ready-Mixed Concrete

THE subcommittee on ready-mixed concrete, representing Committee C-9 of the American Society for Testing Materials, has in preparation a purchase specification for ready-mixed concrete which is expected will meet with considerable favor when available. With the widespread use of this type of concrete it is especially urgent that a standard specification be drawn up to enable all those who plan to use this material to purchase it under a definite standard.

No estimate can as yet be given on the probable date by which the first draft of the specification will be available.

Cloyd M. Chapman, consulting engineer, New York City, is chairman of Committee C-9, and the secretary of the Committee is Stanton Walker, of the National Sand and Gravel Association, 545 Munsey Building, Washington, D. C.

Investigating the Concrete Arch

C. E. HALL and B. S. Tucker, graduate fellows in civil engineering, Ohio State University, are conducting experiments and calculations at the engineering experiment station of the university, with the view of determining the elastic properties of reinforced concrete arches on high, slender piers. The experiments are being made with celluloid models.

The actual arches are later to be built at the University of Illinois, after which load tests will be made and results compared with those obtained from the celluloid models used at Ohio State University.

Burial Vault Specifications Available

THE Tentative Specification for Concrete Burial Vaults (709-32-T), adopted as a tentative standard at the last annual meeting of the American Concrete Institute, has been made available in a separate publication in the form of a 4-page leaflet.

This specification has been developed as a result of several years of co-operation between Committee 709 of the Institute, and a committee representing the National Concrete Burial Vault Association.

Copies of the specification can be obtained from the American Concrete Institute at 10 cents for single copies, 5 cents each in hundred lots, or 4 cents each in lots of 250 or more.

Review British Regulations Governing Reinforced Concrete

A COMMITTEE has been set up by the Building Research Board of the Department of Scientific and Industrial Research of the British Government to review present methods and regulations for the use of reinforced concrete in building construction and to make recommendations for rules of practice embodying the best available technical information and experience.

The functions of the committee are limited to the drawing up of technical rules of practice based on existing knowledge and experience. No special funds are available for research and the committee is in no way concerned with the framing of legal regulations or with other administrative action.

The director of building research, Dr. R. E. Stradling, is acting as executive officer to the committee.

A. S. A. Approves Standard for Steel Reinforcing Bars

AN American Standard for Steel Reinforcing Bars (A47-1932) has been approved by the American Standards Association. The new standard gives 11 standard cross-sectional areas for steel reinforcing bars, ranging from 0.05 to 1.56 square inches.

The standard was submitted jointly by the Concrete Reinforcing Steel Institute and the National Bureau of Standards, as endorsing sponsors. The Institute, which represents a large percentage of the fabricators of steel reinforcing bars, has strongly promoted the establishment of the standard in question, while the Bureau of Standards has published the standard as Simplified Practice Recommendation R26-30.

Copies of the standard can be obtained at five cents each from the American Standards Association, 29 West 39th Street, New York.

Revised Standard for Joist Forms Accepted by Industry

THE revised simplified practice recommendation R87-32, entitled "Forms for Concrete Joist Construction Floors," has been accorded the required degree of written acceptance by all interests, and is to be considered as in effect on May 1, 1932, according to an announcement by the division of simplified practice of the U. S. Bureau of Standards.

This simplification provides for widths and depths, in inches, of standard and filler forms. It also establishes widths, lengths, and taper, in inches, for standard end taper forms. Important changes made in the revised recommendation are the elimination of the 12 and 16-in. filler forms, and the insertion of a table covering standard end taper forms.

Freezing and Thawing Test Procedure

A SUGGESTED method of procedure for making freezing and thawing tests of concrete and concrete aggregates is being prepared by a subcommittee of Committee C-9 on Concrete and Concrete Aggregates, of the American Society for Testing Materials.

It is probable that the subcommittee's report will be ready for presentation before the coming annual meeting of the A. S. T. M.

Develop Burial Vault Business in Community of Ordinary Size

Contractors and Products Manufacturers Show Interest in Steadiness of Market—Quality, Appearance and Courtesy Are Essentials—Several Typical Plants

By C. C. MILLHOUSE
Treasurer, The Automatic Sealing Vault Co., Peru, Ind.

IN the last two years, as never before, men in all industries and in all lines of business have come to a realization of the importance of a steady market—a market that is fairly regular from year to year, one that avoids the extreme fluctuations between boom years and dull years.

Two Extremes of Market Demand

Curiously enough, in the field of concrete products manufacture there are two products, made with similar molds and by a similar manufacturing process, which represent two extremes of market demand.

One of these products is the concrete burial vault, for which the market is steady, fluctuating only moderately from year to year. The product on the other extreme is the concrete septic tank, for which the demand fluctuates greatly. This product is utilized essentially in the construction of improvements—in creating more healthful conditions in the rural home, the rural school and other institutions which are not reached by city sewer systems.

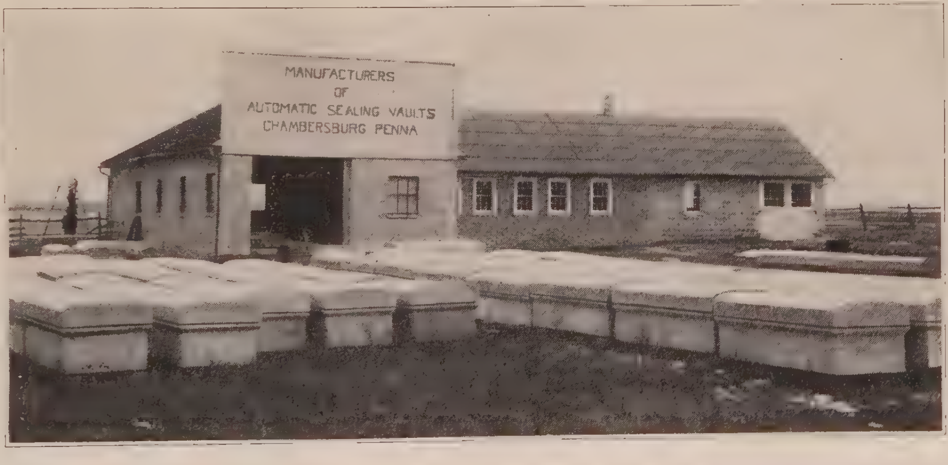


Figure 1. Burial vault plant of J. H. Sleichter, Chambersburg, Penna., maintains attractive storage yard display

Quite naturally, during dull periods many improvements are deferred in order that the diminished available funds will be sufficient to take care of the more urgent necessities. This is true, regardless of whether the person controlling the expenditure is a private citizen who is spending his own funds or a public official who is spending public funds.

From what has been said, one may gather the erroneous impression that the manufacture of concrete septic tanks is a poor business to undertake. That is not true; for, on the contrary, the manufacture of concrete septic tanks can be developed into a very profitable line. The important consideration is that a products manufacturer should not depend on this line alone. He should hook up the manufacture of septic tanks with a more steady line, for which there is a continued market through dull times as well as in more prosperous periods.

Considering, then, that the desired steady market can be realized in the manufacture of concrete burial vaults, and that the molds and the manufacturing process are similar to those employed in the manufacture of septic tanks, these two products make an excellent combination. In other words, while the market for septic tanks fluctuates too much to make this product a desirable line by itself, it constitutes an excellent product to be manufactured in conjunction with concrete vaults. It supplements the more steady vault business, adding to the scope of the manufacturer's field of activity. It adds a considerable volume to his business in good years, and at least a small volume in dull years.

Contractors Interested in Vault Manufacture

These two products form an ideal combination, not only for manufacturers already in the concrete products business, but for concrete contractors as well. It is a fact that in our long experience as manufacturers of molds for making concrete burial vaults and septic tanks, we get almost as many inquiries from men in the contracting business as we do from those in the general products manufacturing field. During the past two years the inquiries from these two groups have been about equal in number. It is apparent that the concrete contractor, no less than the concrete products manufacturer, is seeking to broaden his field.

Figure 2. Burial vault plant of Pile Brothers, at Friedens, Penna., near Somerset

Results in a Few Typical Cases

Since in such a combination the burial vault business will obviously be the principal line, let us now consider the practical aspects of this product. How is it made and what is the volume of the available market? These questions can be answered to the best advantage by telling about what has actually been accomplished in a few fairly typical plants, where the market conditions are the conditions usually encountered in the average community.

The Sleichter Plant at Chambersburg

The plant operated by J. H. Sleichter, at Chambersburg, Penna., provides a typical case of what may be accomplished in a market of ordinary size. Chambersburg had a population of 13,813 in 1930. It is the county seat of Franklin County, which had a total population of 65,010. Thus it will be seen that here we have an average county seat town in a county somewhat above the average in population.

Mr. Sleichter entered the burial vault business early in 1930, and he has built up a business running from 300 to 400 vaults per year. He manufactures other lines of concrete products, but under present conditions he devotes most of his efforts toward the development of his vault market.

Quality, Appearance and Courtesy

Mr. Sleichter, with a plant of only moderate size, adheres to the three business principles that are absolutely necessary to the successful operation of a burial vault plant. The first of these is a high quality product; the second is a product of attractive appearance; the third is efficient and courteous service at the cemetery.

He stores his surplus stock in the yard surrounding his factory and keeps this stock clean and attractive, as the illustration shows. This is just good advertising. He has a storage room with space to keep several vaults of all sizes, all ready for delivery. As fast as this inside stock is sold it is replenished from the outside storage yard.

The Manufacturing Process

In the manufacture of his vaults he uses a mixture of one part of portland cement to three parts of well graded washed sand, running in sizes up to small gravel. The walls of the vaults are reinforced with steel, placed both vertically and horizontally, and the bottom is also reinforced, both crosswise and lengthwise. The walls are 1¼ in. thick and the bottom is 1½ in.

A mixture of rather plastic consistency is placed in the bottom and side walls, though in plants equipped with high-frequency vibrators a much stiffer consistency can be used.

For molding the lid a stiffer mixture is used, and a layer of concrete equal to half the finished thickness is placed. Bars of steel reinforcement are then bent over the lid, in contact with the first layer of concrete. Additional reinforcement is placed lengthwise, after which the lid lifts are placed in position, the shanks of the lifts being anchored under the reinforcing steel. The remaining concrete is then placed over the steel reinforcement and the top of the lid is finished.

Vaults Finished and Painted

Each vault is coated with a waterproofing treatment, after which the surface is finished with a thin slush of neat cement and rubbed by hand with a gunny sack. This fills any small holes and leaves the surface in a polished condition. Before delivery to the cemetery each vault is given two coats of a high-grade cement paint, and great care is taken to keep the vaults clean and attractive at the cemetery. Mr. Sleichter's trucks and delivery equipment are kept in first class condition and the men who attend to the delivery work are courteous, experienced and efficient.

Figure 3. Storage yard of The Duncan Concrete Works, at Bradentown, Fla., where a substantial market for burial vaults has been developed

Pile Brothers Plant at Friedens

Pile Brothers, of Friedens, Penna., began the manufacture of concrete burial vaults in 1924. Friedens is only a small village located a few miles from Somerset, the county seat of Somerset County. The entire county had a population of 80,764 in 1930, while the county seat had a population of 4,391. Pile Brothers were manufacturing other lines of concrete products prior to 1924, and for a time they continued that work in conjunction with their vault business. In spite of the fact that their locality was not familiar with concrete burial vaults, they enjoyed a good volume of business from the start. Sales increased each year, and now they devote their entire time to the manufacture of vaults.

Pile Brothers' manufacturing methods are similar to those already described in connection with the Sleichter plant at Chambersburg, and they follow the same policy of maintaining high quality, good appearance, and courteous service.

Florida Plant Develops Good Volume

The Duncan Concrete Works, at Bradentown, Fla., is another concern that has built up a good volume of business in the concrete burial vault field in a community of ordinary size. Bradentown had a population of 5,986 in 1930, and is the county seat of Manatee County, with a population of 22,502.

An almost endless number of instances could be cited where manufacturers of concrete burial vaults have built up a profitable and well established business in sections not containing large centers of population. The three cases here given are typical of what can be accomplished by a progressive and enterprising manufacturer in a market of only moderate size.

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Use and Handling of Bulk Cement on Concrete Highway Work

Buggies and Platform Scales, Conveyors, Elevators and Batching Bins Employed—24 States Have Used Cement in Bulk—Need for Simplified Equipment Seen

The gradual increase in the use of bulk cement in state highway work quite naturally raises the question as to the manner in which the cement is handled.

That question is answered in this digest of replies received from 43 state highway departments in response to letters addressed to them by "Concrete."—The Editors.

AT least five state highway departments use bulk cement in all or nearly all concrete highway construction work. These five are New York, the District of Columbia, Wisconsin, Kansas and Arkansas. In addition, Texas and New Hampshire use much of their cement in bulk form.

Twenty-Four States Have Used Bulk Cement

One of the states just named—Kansas—actually specifies bulk cement on all concrete paving work. Seventeen other states have used some bulk cement, so that a total of 24 of the 43 states reporting, or 56 per cent of the states, have had some experience in this direction. This may be compared with 42 per cent in 1930. The extent of this experience ranges all the way from "practically none" in Illinois to 100 per cent bulk cement in Kansas.

Two States Forbid Use

Nineteen states have not used bulk cement. Seventeen of this number have simply reported no experience in handling cement in this form; but two states—New Jersey and Florida—actually forbid its use.

Aside from the statement that "bulk cement is not allowed in the specifications," no reason for this attitude is given by H. C. Weathers, division engineer of tests for the State Road Department of Florida. From New Jersey, however, R. B. Gage, chemical engineer for the State Highway Commission, writes: "The use of bulk cement is not permitted. To date no equipment has been devised that will eliminate the trouble encountered in the skip by having the cement and aggregates mixed. Our present method requires the cement to be dumped from the bags directly on the coarse aggregate in the skip."

In contrast to the foregoing, comments from the states in which practically all highway cement is used in bulk form will be of interest, particularly with reference to the methods of handling.

"During the past season," writes E. C. Lawton, construction deputy, New York State Division of Highways, "we have used bulk cement in practically all pavement work. It has been handled by means of automatic weighing devices and so controlled as to insure a variation not exceeding 1 per cent above or below the quantity specified."

From Kansas, H. Allen, materials engineer, State Highway Commission, writes that bulk cement is used on all paving work, and that the cement is handled by means of concrete buggies over a platform scale.

A similar method of handling is employed in Arkansas, according to W. W. Zass, engineer of construction, State

Highway Commission, who states that "bulk cement was used on about 90 per cent of the paving work in 1931. The cement was handled from the car to the truck by means of buggies, either of the bottom-dumping or the tilting type."

Frederic E. Everett, commissioner and state engineer, New Hampshire Highway Department, writes that much bulk cement is used, and that it is handled by weighing it into wheelbarrows which are weighed on a set of platform scales and then dumped into special compartments, which are covered.

Use of Canvas Bags

H. C. Whitehurst, engineer of highways, District of Columbia, tells of the use of canvas bags in handling bulk cement. "A large percentage of the cement used by this department," he writes, " is handled in bulk. Both metal and canvas bag containers have been used in transporting the cement from the warehouse, where delivery is made by weight, to the mixer. The use of the canvas bag attached to the gates of the batched trucks has proved especially satisfactory, and it is believed that it offers one of the best methods of handling bulk cement when transporting in batches."

Handling Equipment in Wisconsin and Texas

"The majority of our concrete paving work in Wisconsin utilizes bulk cement," states E. L. Roettiger, assistant construction engineer, Wisconsin Highway Commission. "The cement is handled by trucks from cars or silos to proportioning plants, or handled directly from cars to proportioning plants. The weighing equipment used varies from combination platform scales and concrete buggies to standard batcher type proportioning plants equipped with bucket elevators."

The practice in Texas seems to be similar to that in Wisconsin. Gibb Gilchrist, state highway engineer, Texas State Highway Department, writes: "Our specifications allow the use of bulk cement on all projects, on condition that the batching equipment is approved by the construction division. We have three or four batching plants which employ storage bins and weighing equipment similar to standard aggregate handling equipment; but the greater number of our contractors are using concrete buggies and platform scales, handling the cement by hand and adjusting the weight on the platform scale, and then dumping this cement on the top of the truck, where it is covered with a tarpaulin while being hauled to the mixer."

General Use of Handling Equipment

While many states report the use of concrete buggies and platform scales in handling bulk cement, the fact remains that more efficient handling equipment is in general use.

In Pennsylvania, according to Samuel Eckels, chief engineer of the State Department of Highways, bulk cement must be proportioned by weight. In general, the contractor uses a separate bin with an approved method of conveying the cement to the bin. The cement must be transported to the work in watertight compartments separate from the aggregates. The use of small buggies weighed on platform scales has also been permitted.

R. W. Coburn, construction engineer, Massachusetts Department of Public Works, states that bulk cement was used on several highway contracts in 1931. "The cement was conveyed," he continues, "from the cars to separate bins with two different kinds of mechanical conveyors, and the quantity of cement necessary for the individual batches was determined by weighing."

J. T. Ellison, chief engineer, Minnesota Department of Highways, writes that bulk cement has been used successfully on highway work in that state for 7 years. It is handled either in hand buggies or by special cement unloading and weighing equipment.

In North Carolina, according to John D. Waldrop, state construction engineer, only high-class handling equipment is permitted in the handling of bulk cement. "The type of apparatus used on several projects in 1931," he says, "was a large bin with automatic feeding and control systems, and the cement was weighed by an automatic weighing device which operated accurately and satisfactorily."

From Missouri, T. H. Cutler, chief engineer, State Highway Department, writes that where bulk cement was used on special jobs it was handled by approved mechanical methods.

Compartment Trucks in Washington

T. G. McCrory, chief engineer, Washington State Department of Highways, writes: "The bulk cement on one paving job was handled by elevator from the cars to the storage bin. From the storage bin it was weighed into a batch bin and deposited in a separate compartment in the aggregate batch trucks. These trucks held three batches. The coarse and fine aggregate were first weighed into the truck, after which the cement was deposited in its compartment. At the mixer the cement compartment was opened with the aggregates and the cement was deposited in the skip of the mixer at the same time."

Tennessee is using bulk cement for the first time in 1932, according to T. C. McEwen, state highway engineer. Mechanical handling equipment is being specified.

Indiana expects to increase the use of bulk cement. William J. Titus, chief engineer, State Highway Commission, writes: "In some instances bulk cement was handled by rather elaborate plants, such as are manufactured and sold by some of the equipment companies. In other instances the cement was loaded by hand from the cars into small buggies and weighed on platform scales. Both methods are satisfactory from our standpoint, as well as the contractors', and we plan to increase the use of bulk cement on our paving projects."

"In Ohio," writes Neal Moler, assistant engineer, bureau of construction, State Department of Highways, "bulk cement is usually removed from the car in buggies, weighed, then dumped into a separate container on the truck. The trucks usually pass under a bridge from the car, and platform scales are on the bridge."

A similar method is used in Kentucky, according to H. D. Palmore, state highway engineer, who states that the bulk cement is received on a platform adjoining the railroad siding, after which the cement is weighed on platform scales and dropped through chutes on top of the aggregates in the batching truck.

In Georgia, as in many other states, contractors may use either concrete buggies and platform scales, or more elaborate equipment, writes M. E. Cox, contact engineer, State Highway Board.

A study of these letters from highway engineers impresses one with the need for simple, but efficient, equipment for handling bulk cement on concrete highway work. It will be interesting to see what effect the recent development of special bulk cement railway cars will have on the use of bulk cement on highway work. When bulk cement railway cars are available to all cement manufacturing companies, the use of cement in bulk form on highway work should be simplified, and therefore stimulated.

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Watertight Forms Essential for Good Concrete Work

By **GEORGE HOCKENSMITH**
Vice-President, Booth & Flinn Company, Pittsburgh, Pa.

Leakage of Mortar Through Cracks in Forms Leaves Porous Concrete — Rubbing Detrimental to Surface Concrete — Veneer Lining Solves Problem

AFTER making numerous experiments and tests, I have concluded that the fundamental cause of disintegration of concrete in cold climates is not that the concrete has been placed in cold weather. The real cause is to be found in the porous surface of the disintegrating concrete.

On any job where disintegration takes place, one will find that the forms have been built in rough fashion, with cracks in the corners and between the boards from 1/16 in. to ½ in. wide. These cracks permit the mortar and water to leak out, leaving porous concrete at every crack. A magnifying glass discloses hundreds of pinholes penetrating 4 or 5 in. into the concrete. Each tiny stream of leakage leaves its pinhole extending into the heart of the concrete. The same phenomenon occurs whether concrete is poured in summer or winter.

When cold weather comes, with fogs or rain during the day and freezing temperatures at night, the pores fill with water. During cold nights the water freezes into ice and expands, fracturing the concrete. The first fracture will not appear to the naked eye; but the second and third freeze will spall the concrete slightly. After a couple of seasons of freezing and thawing, the concrete will break loose and drop out to a depth of 2 or 3 in.

Leaking Forms

Every construction man has seen concrete jobs on which water has run and dripped off the forms. This escape of water indicates either that the forms leak, or possibly that the concrete is too wet. To prevent the disintegration of concrete, the forms must be watertight and the batch must be mixed with a minimum water-cement ratio. No water should leak through the forms. All of it should be taken up in chemical combination during the setting of the concrete. If forms are watertight, examination of the concrete will reveal no pores or pinholes, and the danger of freezing and cracking will be eliminated.

Great care should be given to the form work and to the proper working of concrete while it is being placed. Forms made of ordinary lumber should be constructed of tongue-and-grooved lumber, and all joints should be made watertight.

Thinks Rubbing Is Harmful

Concrete, if placed and tamped properly in watertight forms of correct design, has a smooth surface covered with a thin film of mortar. Breaking this film exposes the pores and leaves the concrete liable to disintegration. Many architects and engineers specify that concrete surfaces shall be rubbed with carborundum stones, either by hand or by power. This rubbing injures the concrete by destroying the protective film. A slight scaling of the surface is always observable on rubbed concretes in cold climates.

If forms are properly built, with good lumber, the concrete surface ought to be smooth and free from fins and honeycomb. It would seem advisable, therefore, to eliminate rubbing from concrete specifications and to require that forms and placing methods be such as to leave a smooth concrete surface with a dense film of mortar which needs no retouching.

Recommends Use of Quarter-Inch Lining

For the last four years we have lined with ¼-in., 3-ply veneer all forms for concrete exposed to the weather, thereby preventing leakage through cracks and insuring a smooth, dense surface. Specifications should cover the kind of material, number of times lumber may be used, and other details of good form construction. The writer believes that the precautions above outlined can be depended upon to prevent concrete disintegration.

Having had quite a controversy with engineers in the past two years regarding rubbing concrete, about a month ago we made an investigation of concrete that we had placed with ¼-in. veneer, and concrete which had been stripped the day after placing and then rubbed and ground

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Paper presented at annual meeting of Associated General Contractors of America, Milwaukee, Wis., Jan. 18-21, 1932.

to a smooth, even surface. Both of these jobs had been in place for six months. It was actually shown that where concrete had been rubbed while green, you could take an ordinary penknife and rake the surface of the concrete for a depth of at least ¼ in., showing that it had been killed while in the stage of setting, by the rubbing. The concrete where the veneer-lined forms had been used and not rubbed was as hard as marble. It was impossible to mar it with a knife. This experiment was made on a state job where they claim their methods are far superior to any other method. Their chief engineer was very much surprised, when he found out the conditions.

Large Panel Effects From Veneer

The veneer comes in panels from 2 by 4 to 4 by 8 ft., and of course this leaves the effect of panels; but this is not distasteful to the eye. If the design of concrete structures should require the panels to be placed in squares, then by using a small chamfer strip it would produce a beautiful job and add to the life of the concrete. The outside surface of a concrete wall of any size will expand and contract much faster than the inside of the wall. Therefore, that is the cause of surface cracks on the face of the concrete, which run only a depth of from ½ to 2 in. By using chamfer strip of at least ½ in. in depth, surface cracks in concrete retaining walls and piers and similar outdoor structures will be eliminated.

Where Vibrators Should Be Used

Architects and designing engineers should give more thought as to how concrete should be placed. The writer has placed columns 20 in. square and 100 ft. high in the past two years, with web walls between the columns only 6 in. thick. A form this size makes it impossible to put a man inside to spade the concrete, and the only way it can be done is to use vibrators on the outside of the forms. In most cases the specification does not say the contractor shall use a richer mix or a smaller aggregate; and therefore he does not go to the extra expense of obtaining an aggregate which would eliminate honeycomb. In many cases the concrete is placed without vibrating, and patching is necessary, which always leaves a bad appearance on the surface.

First Concrete Pavement Placed Forty Years Ago

This year marks the fortieth anniversary of the oldest concrete pavement in the United States.

In 1892, Bellefontaine, Ohio, installed strips of concrete on streets on two sides of the courthouse. Streets on the two remaining sides of the courthouse were paved the following year.

New Cements Featured at British Trade Fair

At the British Industries Fair, the world's largest national trade fair, held in Birmingham, England, during February and March, the Cement Marketing Co. had an attractive display of modern decorative effects obtained by the use of white and colored cements. A new product shown was Snowcrete, claimed to be the only pure white portland cement manufactured in the United Kingdom. The most recent development in the use of cement as a decorative medium, Tintocrete, was also featured by the combine. The Tintocrete spraying process applies a thin coating of cement to various types of surfaces, giving a hard, smooth finish of any color.

How Cleveland Contractor Develops Home Improvement Business

Sales Letter to Home Owners Draws Inquiries—High Class of Work Shown in Illustration

How the E. H. Hatcher Company, a Cleveland contracting concern, goes after concrete work involved in the improvement of home grounds is best told in this sales letter to home owners. The letter follows:

> Right now when it's smart to be thrifty, why not invest the vacation money in improvements around the home?
>
> For after all, where can more real pleasure be found by the entire family than in a home boasting of a rock garden, a tennis court, a colored concrete dining terrace, a miniature golf course?
>
> We are specialist contractors in all kinds of improvements around the home. Four winters' work in Florida have furnished us with a large fund of ideas that are yours for the asking.
>
> Phone us when it will be convenient to call. Or check off on the above list the improvements you are interested in and return this letter to us with your name and address on it. We'll do the rest. No obligation to get our ideas.

A postscript reminds the recipient of the letter that this company has been doing this type of work in Cleveland for 14 years.

The illustration shows an example of the Hatcher company's work—a concrete lily pool, 3 ft. deep, 28 ft. wide and 36 ft. long. In plan the pool has two semi-circular ends, joined by a straight stretch of 8 ft. long. In cross-section the pool is bowl shaped, the slab being 8 in. thick.

Bowl-shaped concrete lily pool, 28 by 36 ft. in plan, placed by E. H. Hatcher Company

The concrete in this work was mixed in the proportions of 1:2½:3½, ordinary portland cement having been used. The entire inside of the pool was painted with a blue cement paint made by Medusa Portland Cement Co.

Testing Aggregates and Steel Bars

Aggregates an Unknown Factor—Selection of Samples and Testing Procedure—Shop Inspection of Steel Bars—Need for Unbiased Inspection

By D. B. RUSH
Manager, Cement and Concrete Dept., Robert W. Hunt Co., Chicago, Ill.

In the two remaining articles of this series of seven the author will discuss the molding, curing and testing of concrete cylinders, and field supervision of concrete construction work.—The Editors.

IN every branch of engineering science the desire and trend has been to reduce all factors to common standards and to build up formulas on these standards. The loads to which the building will be subjected are calculated, and in general the planning of a building is largely a problem of mathematics with certain definitely known values to form the basis of the calculations. In recent years the study of what makes concrete of definite strengths has advanced so far and accepted practices have become so standardized that the engineer is justified in assigning certain values to his concrete design with the confidence that such values will be present when the structure is completed.

Aggregates an Unknown Quantity

In order to attain and maintain certain calculated values in concrete design, however, account must be taken of the fact that unless the concrete be handled with the greatest of care, such values will not be realized. The reason for this is that although the cement is now a practically uniform product (barring accidents) the aggregate is still, to a large extent, an unknown quantity.

Aggregate is divided into two main divisions—fine and coarse. Fine aggregate has arbitrarily been set as that which will pass through a ¼-in. sieve and is usually sand; while coarse aggregate is that which will not pass ¼-in. sieve and may be any one of a great number of materials, varying widely in their size, strength and other qualities. Gravel and crushed stone are the two most common forms of coarse aggregate, but slag, cinders and almost any other hard material may be used.

Concrete is aggregate firmly held together by cement which has reacted with water. The ideal aggregate is that which is so graded as to form a mass containing the fewest voids, yet containing particles large enough to give strength without being so large as to be cumbersome or impossible to use in forms and in reinforced work. In other words, aggregate must be balanced in relation to a number of physical requirements, both in relation to the strength of concrete desired and the form into which it is to be cast. The importance of obtaining the best aggregate in correct proportions may be realized when its large bulk in relation to the cement and water used is considered.

Determining the Fitness of Aggregate

The proper study of aggregate in the field will take into consideration the size and grading of the aggregate and the quality of its individual particles. In order to do this properly these properties are studied separately for sand and coarse aggregate and the mix designed from the results shown by the tests.

To be considered a fit material the fine aggregate must be clean, hard and well graded within the set limits. The inspector, therefore, sets about to determine these qualities. His equipment consists of a number of graded screens from ¼ in. to No. 100, scales or volume measures, and several bottles. The sand is graded through the screens. The summation of the results obtained by weighing or measuring the per cent retained on each screen is called the "fineness modulus." Normally not more than 5 per cent should pass through the No. 100 screen; and if this happens, the sand is immediately rejected as containing too much useless fine material. Sometimes the specifications will stipulate the limits within which the fineness modulus must fall, and if such is the case this feature is carefully watched. In most cases, however, the inspector is allowed to use his own judgment in regard to the grading of the material.

Having determined the size, the other physical qualities of the sand are next determined by the inspector. The quantity of silt is found by the decantation method. Shale, clay and other soft materials are generally tested for, by using a liquid of greater specific gravity than water, or by boiling.

Test for Harmful Matter in Sand

Organic or other harmful matter in either the fine or coarse aggregate may result in failure of the concrete, even years after the structure is finished. There is a very simple method of determining, qualitatively, the presence of such matter, by merely applying a 3 per cent solution of sodium hydroxide to the sample of the aggregate and allowing the solution to stand at rest for some 24 hours. After this period, if the liquid on top of the sand is clear, or of a light yellow color, the aggregate is satisfactory for use; but if a darker color appears, it is probable that a considerable quantity of undesirable material is at hand, and the inspector immediately starts more elaborate chemical and physical tests to determine both the quality and quantity of such harmful materials.

Moisture content, bulking, and the hardness of the sand particles are next determined. The moisture content may be found by comparing the weight of a sample of the sand as it is delivered, with the same sample after it has been thoroughly dried. Bulking is caused by the moisture content and its extent may be found either by comparing the volume of undried to dried samples, or a given quantity of bulked sand may be allowed to pass slowly into a measuring can full of water. The sand thus treated will be impacted to the same volume as if it were dried. It is necessary to determine these two factors in order that the mix may be designed properly later.

The hardness of particles may be determined approximately in the field, but in case there is a decided question, here again either the fine or coarse aggregate must be submitted to a competent laboratory where the proper tests are made for wear, hardness and weathering, preferably by actually freezing and thawing the material.

The requirements for coarse aggregate are the same as for fine. The stone must be properly graded, hard, clean and free from impurities. Its bulkage and water content are also important features.

Selection of Samples

In order to make intelligent tests it is necessary to obtain truly representative samples. This is usually done by the quartering method. After about 80 lb. of aggregate are taken from a number of locations in the pile—top, bottom and interior—the sample is spread out on a board platform and divided into quarters. Opposite quarters are discarded. The remaining material is mixed, spread out and again quartered. This operation is repeated until about 20 lb. remain. Tests are made on this representative sample.

The care given to the aggregates after they have been received is also important. They should be stored in a clean spot and care should be taken that none of the natural soil is shoveled up when the barrels are loaded. As most aggregate is stored in the open, weather conditions will be a factor in daily changing the moisture content and bulkage. In order to keep a check on this feature, not only should every load be thoroughly inspected and tested, but all materials on the site should be tested every day and calculations based upon any changes found in their condition.

Disinterested Inspection Needed

An independent inspector should make these tests. In the first place, few contractors are interested enough or willing to make them. Even if the contractor should be willing, he might not have the equipment or knowledge necessary to make the tests and use the facts gained. The time necessary to attend to such details is also a deterrent factor to the assumption that the contractor will perform the tests adequately. Reliance on municipal inspectors is likewise futile. Their visits are too infrequent and short to permit them to give much of their attention to such details. The contractor, too, may have an interest in the material supply business, which would render him unfit to pass on the quality of the delivered aggregate. These and many other factors point out the logic of employing only independent inspection service to pass on construction materials.

One of the very important factors which goes into the making of successful concrete is the steel reinforcing bars. Concrete foundation mats were a failure until the principle of placing concrete bars in them gave the necessary strength to resist unequal pressures. It is evident that without proper reinforcing our modern 21-story concrete buildings would be impossible. The inspection and testing of steel reinforcing bars is, therefore, just as important as the testing of any of the other ingredients of concrete. It is essential to know that you get what you order; that when rerolled rail stock is wanted, it is delivered; that when new billet stock is ordered, it is delivered; that bends, if shown on the blueprint, are properly executed; and that, in general, every detail is thoroughly checked. The time to see that material is satisfactory is before it arrives on the job, where rejection will result in expensive delays.

Procedure in Testing Steel Bars

The several classes and grades of reinforcing steel are rolled by the various manufacturers from new billet stock or from old or new mill second-quality rails. The possible lack of uniformity in the chemical and physical properties of a lot of bars is therefore readily apparent and indicates the desirability of having a representative at the manufacturer's plant during rolling of the order to inspect and test this material carefully before shipment. At the rolling mills and warehouses inspectors witness tensile and cold-bend tests made on specimens selected from the various sizes of bars in each lot and only such material as complies with all specified requirements is accepted for shipment. A general inspection is made of the material, in so far as mill and warehouse conditions permit, for surface defects, section and weight. The inspector also checks the material to see that all accepted bars bear mill identification marks, and that all bundles or lots bear legible tags showing the manufacturer's name, bar size, and heat number.

All bars from which test specimens are taken if material meets specifications are identified with the laboratory's serially numbered tags.

Activities of Road Builders Group Reviewed in Annual Meeting

Activities of the American Road Builders' Association as reported to the annual meeting on April 28 covered practically all highway activities. The association agreed to join with other groups interested in highways in a Construction Congress to be held this winter. The meeting was held at Washington, D. C.

Work of the various divisions of the association during the past year shows a maximum degree of co-operative effort on a wide variety of subjects relating to road and street activities. Not only has this co-operation been with various nation-wide organizations, but it has also included effective work with some 19 state associations of county officials and many municipal organizations. In 302 of the 374 cities of more than 25,000 population, intimate contact is maintained through representatives.

In general engineering and committee activities, co-operation was effected with a score of trade associations. During the 24 convention sessions devoted to highway research at the annual convention in Detroit this year, there were presented 86 technical reports and papers dealing with current practice. Some 15 of these reports were joint efforts with other associations.

Cure Concrete Highway Slabs With Heavy Kraft Paper

Method Found Highly Efficient—Material Given Five Uses, But Good for Several More—Moisture Loss Very Small

By MARK MORRIS
Research Assistant, Iowa State Highway Commission, Ames, Iowa

AS a continuation of the extensive study of methods of curing concrete undertaken several years ago, this department, during the construction season of 1931, investigated the use of two heavy duplex papers proposed by their respective manufacturers for use in curing concrete pavements and concrete floors.

These duplex papers are of similar construction, each consisting of two or three layers of heavy kraft paper sealed together with a thin coating of asphalt. The principal difference in the papers is in the method of reinforcing the paper itself. In one kind the reinforcing material consists of sisal fibres placed thickly, but at random, throughout the paper, and in the other, the reinforcing consists of continuous strings regularly spaced in a diamond mesh pattern.

This interesting story of the results obtained in the use of heavy kraft paper in the curing of concrete highway slabs is the author's abstract of a more detailed but unpublished departmental report prepared by him.

The work here described is part of an extensive study of curing methods inaugurated by the Iowa State Highway Commission several years ago.—The Editors.

Placing the Paper

These papers are manufactured in strips about 7 ft. in width. In use, three strips about 50 ft. in length are sealed or sewed together to form one piece. This piece is readily handled by rolling it on a 1 by 4 board. The paper is then applied to the pavement by unrolling this piece along the pavement to be cured. A small ridge of soil is formed on the paper near the edges of the pavement and across the pavement at the lap of two adjoining sections of paper. A 15-in. to 20-in. pleat is folded longitudinally in each section of paper to allow for shrinkage across the pavement. For the same reason a generous lap is allowed at each end of the sections of paper. As used experimentally in Iowa, the papers were applied about 24 hours after the placing of the concrete, the initial curing being accomplished under wet burlap.

In Good Condition After Five Uses

In order to compete successfully on a cost basis with moist earth curing, these papers must be used several times, probably 5 to 9 times. As a result of the field trials, it was demonstrated that each of the papers could be applied at least 5 times without appreciable depreciation of its efficiency as a curing agent. Completion of the paving projects where the paper was being used prevented experimental applications, but the paper was in good condition for further use, at least for 2 or 3 applications.

Given Laboratory Test After Each Use

At each application of the paper, samples of it were taken and given a rigorous test in the laboratory to determine its ability to prevent loss of moisture from mortar cured for the first 24 hours after placing, under wet burlap. When subjected to atmospheric conditions in which the temperature of the air was 93 to 98 deg. F. and the relative humidity values varying from 33 to 35 the paper showed, initially, a very high efficiency in the prevention of moisture losses, and progressively a lower efficiency for each subsequent application. However, at the end of the fifth application, the paper permitted a relatively low moisture loss when the maximum allowable loss is considered. On the basis of this test the paper could well have been used for several more applications.

Far Above Standard Requirements

From previous work on methods of curing concrete, it has been found that satisfactory curing requires that the concrete retain at the age of 6 days at least 80 per cent of the original water content. These papers showed losses varying from 0.61 to 4.29 per cent at the initial application of the paper, and from 2.00 to 7.87 per cent after the last application. Concrete losing this small amount of water in six days may be considered to have received satisfactory curing. Properly handled, therefore, these duplex papers were found to provide a satisfactory means of curing for concrete pavements.

Reinforcing Institute Moves

The Concrete Reinforcing Steel Institute has removed its offices from 420 to 333 North Michigan Ave. at Chicago.

Concrete Made on Construction Site Must Equal Ready-Mixed

Contractor Now a Manufacturer of Concrete—Must Prove Ability to Produce Job Concrete of Specified Quality

By **ROBERT C. JOHNSON**
Immel Construction Co., Fond du Lac, Wis.

In this discussion, presented before the thirteenth annual convention of the Associated General Contractors of America as a further contribution to a paper on ready-mixed concrete read by W. E. Hart, manager of the structural bureau of the Portland Cement Association, Robert C. Johnson has sounded a warning to the contractor who is not also engaged in the production of ready-mixed concrete.

Many contractors have entered the ready-mixed concrete industry as producers, partly as a means of obtaining ready-mixed concrete for their own work and partly as a means of enlarging the scope of their business; but obviously, it would neither be possible nor desirable for all the larger contractors to do so. The immediate result would be too many plants.

In a word, many contractors will prefer to continue mixing their own concrete on the construction site; but, as Mr. Johnson explains, these contractors must be able to convince architects and engineers that they understand the practical application of the principles involved in the scientific production of concrete.

Here is an all-important reason why contractors must keep themselves informed on the art of making concrete of pre-determined quality.—The Editors.

As a contractor, and not as a public works official, the thing that has impressed me most about recent developments in cement and concrete is that recognition is now being given to the fact that we, as contractors, are manufacturers. A few years ago we were told that we should use so much cement, so much sand, so much gravel, and that we should mix the material in such-and-such a way. We were told that after following these specifications we would also be responsible for the structure.

Duff A. Abrams, who developed the facts about the water-cement ratio, was taking that position to a large extent. We are now recognized as manufacturers, and that is the result that is desired in the ultimate end.

Recognition of the contractor as a manufacturer had two effects on our business. One is the very rapid development of so-called ready-mixed concrete. Previous to the time when economies in the process of manufacture were made possible, there was no place in our industry for ready-mixed concrete. That is an economy of manufacture only, and makes it possible for a new industry to develop.

Job Concrete Must Equal Ready-Mixed

The contractor, if he wishes to maintain his position as a manufacturer of concrete on the job, must be as efficient as the ready-mixed concrete man. He must, out on the construction site, make those same economies that the ready-mixed concrete manufacturer is making. I am not in any respect opposed to ready-mixed concrete. In many instances I think it is probably better than that which we make on the job. I dislike to admit defeat, but that is what I am doing if I frankly admit that as a manufacturer of concrete I am not as good as the ready-mixed concrete manufacturer.

That is something to which I want you to give very serious consideration. Has the contractor-manufacturer of concrete been able to sell architects and engineers on the fact that he also knows how to manufacture concrete, and that as a contractor he can produce the quality of concrete that he wants?

Keep Informed on Special Cements

There has been one other result of Abrams' development of the water-cement ratio method, aside from the emphasis on the process of manufacture. That is seen in the development of high-early-strength concrete, special-use concrete, and many offshoots of the so-called 1:2:4 mixtures.

There is a difference of opinion on the subject, but I thoroughly believe that one of the large developments to come will be the use of special cements for special concrete requirements.

As manufacturers of concrete we contractors must watch for these cements, we must know how to use them and how to sell them, or we will in turn lose our market.

Coming Conventions

June 20-24—American Society for Testing Materials, thirty-fifth annual meeting. Haddon Hall, Atlantic City, N. J.

Bending Stress in Concrete Columns

By **FRANK A. HILL**
Consulting Engineer, Oakland, Calif.

THE tables here presented provide a short and convenient method for computing bending stresses in rectangular reinforced concrete beams and in both circular and rectangular reinforced concrete columns.

This method of design is based on the principle that the unit stress in the concrete can be obtained by dividing the bending moment by the product of the coefficient and the cube of the diameter or the breadth and the square of the depth.

The formulas in the tables were derived on the assump-

TABLE 1

Section Coefficients for Rectangular Concrete Beams

$$N=\frac{1}{2}\left(\sqrt{1+\frac{2}{pn}}-1\right) \qquad Q=\frac{1}{6}(3k-k^2) \qquad k=\frac{1}{N+1}$$

pn	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	
0.00	——	1.7963	1.1583	0.8845	0.7248	0.6180	0.5408	0.4819	*N*
	——	*.1575*	*.1959*	*.2184*	*.2339*	*.2454*	*.2543*	*.2616*	*Q*
.01	6.5887	1.6898	1.1220	0.8668	0.7131	0.6097	0.5342	0.4768	*N*
	.06296	*.1629*	*.1987*	*.2202*	*.2352*	*.2464*	*.2551*	*.2622*	*Q*
.02	4.5250	1.6016	1.0883	0.8490	0.7015	0.6014	0.5283	0.4718	*N*
	.08503	*.1676*	*.2014*	*.2219*	*.2377*	*.2474*	*.2559*	*.2628*	*Q*
.03	3.6130	1.5239	1.0569	0.8312	0.6899	0.5931	0.5220	0.4669	*N*
	.10056	*.1719*	*.2038*	*.2236*	*.2389*	*.2483*	*.2567*	*.2634*	*Q*
.04	3.0707	1.4548	1.0275	0.8134	0.6783	0.5846	0.5158	0.4621	*N*
	.11275	*.1760*	*.2061*	*.2252*	*.2389*	*.2492*	*.2574*	*.2640*	*Q*
.05	2.7016	1.3930	1.0000	0.7956	0.6667	0.5766	0.5096	0.4574	*N*
	.12293	*.1798*	*.2083*	*.2268*	*.2400*	*.2501*	*.2581*	*.2646*	*Q*
.06	2.4298	1.3371	0.9769	0.7814	0.6569	0.5694	0.5036	——	*N*
	.13163	*.1834*	*.2105*	*.2283*	*.2411*	*.2510*	*.2588*	——	*Q*
.07	2.2196	1.2864	0.9538	0.7672	0.6471	0.5622	0.4978	——	*N*
	.13921	*.1868*	*.2126*	*.2298*	*.2422*	*.2519*	*.2595*	——	*Q*
.08	2.0458	1.2400	0.9307	0.7530	0.6374	0.5550	0.4923	——	*N*
	.14618	*.1900*	*.2146*	*.2312*	*.2433*	*.2527*	*.2602*	——	*Q*
.09	1.9099	1.1975	0.9076	0.7389	0.6277	0.5479	0.4870	——	*N*
	.15216	*.1930*	*.2165*	*2326*	*.2444*	*.2535*	*.2609*	——	*Q*

Using $f_c = 0.40\ f'_c$ for values of $pn < 0.0346$, $f_s > 16{,}000$ and $Q < .1065$.

For values of $pn < 0.0281$, $f_s > 18{,}000$ and $Q < .9787$.

For values of $pn <$ above use (2); for $>$ use (1).

When $pn = 0.1181$, $N = 1.6178$ and $Q = \frac{1}{6}$; i. e., same value as a homogeneous beam.

Where dimensions of beam or slab are fixed, compute Q and select corresponding values from table.

GENERAL FORMULAS

(1) $M = bd^2\,Q\,f_c$

(2) $M = bd^2\,Q\,\dfrac{f_s}{nN}$

TABLE 2

Section Coefficients for Rectangular Concrete Columns

$$N=\sqrt{1+\frac{1}{pn}} \qquad Q=\frac{1}{6}(3pn+3k-k^2) \qquad k=\frac{1}{N+1}$$

pn		0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
0.00	*N*	——	3.317	2.449	2.081	1.871	1.732	1.633	1.558	1.500
	Q	——	*.1569*	*.2307*	*.2947*	*.3540*	*.4107*	*.4659*	*.5200*	*.5733*
.01	*N*	——	3.179	2.399	2.052	1.855	1.721	1.625	1.552	1.495
	Q	——	*.1653*	*.2375*	*.3010*	*.3598*	*.4163*	*.4714*	*.5254*	*.5786*
.02	*N*	——	3.054	2.355	2.025	1.839	1.710	1.617	1.546	1.490
	Q	——	*.1733*	*.2442*	*.3072*	*.3655*	*.4219*	*.4768*	*.5308*	*.5839*
.03	*N*	——	2.949	2.312	2.000	1.824	1.699	1.609	1.540	1.485
	Q	——	*.1811*	*.2507*	*.3132*	*.3712*	*.4275*	*.4822*	*.5361*	*.5892*
.04	*N*	——	2.854	2.273	1.976	1.809	1.689	1.601	1.534	1.480
	Q	——	*.1887*	*.2572*	*.3191*	*.3769*	*.4330*	*.4876*	*.5414*	*.5945*
.05	*N*	4.5826	2.769	2.236	1.954	1.795	1.678	1.593	1.528	1.475
	Q	*.1092*	*.1960*	*.2635*	*.3250*	*.3826*	*.4385*	*.4930*	*.5467*	*.5998*
.06	*N*	4.2032	2.691	2.201	1.935	1.781	1.668	1.586	1.522	1.470
	Q	*.1204*	*.2032*	*.2698*	*.3310*	*.3883*	*.4440*	*.4984*	*.5521*	*.6051*
.07	*N*	3.9097	2.623	2.168	1.918	1.768	1.659	1.579	1.516	1.465
	Q	*.1299*	*.2103*	*.2762*	*.3367*	*.3939*	*.4495*	*.5038*	*.5574*	*.6104*
.08	*N*	3.6742	2.560	2.137	1.901	1.755	1.650	1.572	1.510	1.461
	Q	*.1398*	*.2172*	*.2824*	*.3424*	*.3995*	*.4550*	*.5092*	*.5627*	*.6157*
.09	*N*	3.4801	2.502	2.108	1.886	1.743	1.641	1.565	1.505	1.457
	Q	*.1483*	*.2240*	*.2886*	*.3482*	*.4051*	*.4605*	*.5146*	*.5680*	*.6210*

Using $f_c = 0.20\ f'_c$, for values of $pn < 0.1636$, $f_s > 16{,}000$ on tension side.

Using $f_c = 0.20\ f'_c$, for values of $pn < 0.1250$, $f_s > 18{,}000$ on tension side.

The above table disregards all concrete outside of core. To include cover; let d = effective depth; c = depth to center line steel; $r = \frac{c}{d}$ and p = total area of steel divided by total area of concrete; take tabular values of N and Q and transform as follows:

$$N' = (N - r)/(r+1)$$

$$Q' = Q - \frac{pnr}{2}\left[(N+1)\ (1-r) + r\right]$$

GENERAL FORMULAS

$M_o = bd^2\,Q\,f_c$

$W_s = bd\,f_c\,(pn+1)$

W_a = Actual load

Safe Bending Moment = M_s =

$$M_o\left[1-\frac{W_a}{W_s}\left(\frac{\text{Axial stress}}{\text{Combined stresses}}\right)\right]$$

TABLE 3

Section Coefficients for Circular Concrete Columns

$$N = \sqrt{1 + \frac{2}{pn}} \qquad Q = 0.1836\ (pn + 2k - \frac{2}{3}k^2) \qquad k = \frac{1}{N+1}$$

pn		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.00	N	....	3.317	2.769	2.449	2.236	2.081	1.966	1.871	1.795
	Q	....	*.1152*	*.1439*	*.1696*	*.1936*	*.2164*	*.2384*	*.2601*	*.2809*
.01	N	....	3.249	2.730	2.422	2.219	2.068	1.956	1.863	....
	Q	....	*.1182*	*.1466*	*.1721*	*.1959*	*.2186*	*.2406*	*.2622*	....
.02	N	....	3.181	2.693	2.397	2.202	2.055	1.946	1.855	....
	Q	....	*.1212*	*.1492*	*.1746*	*.1982*	*.2208*	*.2428*	*.2643*	....
.03	N	....	3.113	2.657	2.374	2.185	2.043	1.936	1.847	....
	Q	....	*.1242*	*.1518*	*.1770*	*.2005*	*.2230*	*.2450*	*.2664*	....
.04	N	....	3.055	2.623	2.353	2.169	2.031	1.926	1.839	....
	Q	....	*.1271*	*.1544*	*.1794*	*.2028*	*.2252*	*.2472*	*.2685*	....
.05	N	....	3.000	2.591	2.333	2.153	2.019	1.916	1.831	....
	Q	....	*.1300*	*.1570*	*.1818*	*.2051*	*.2274*	*.2494*	*.2706*	....
.06	N	....	2.948	2.561	2.313	2.138	2.008	1.907	1.823	....
	Q	....	*.1329*	*.1596*	*.1842*	*.2074*	*.2296*	*.2516*	*.2727*	....
.07	N	....	2.899	2.532	2.293	2.123	1.997	1.898	1.816	....
	Q	....	*.1357*	*.1621*	*.1866*	*.2097*	*.2318*	*.2538*	*.2748*	....
.08	N	....	2.853	2.504	2.273	2.109	1.986	1.889	1.809	....
	Q	....	*.1385*	*.1646*	*.1890*	*.2120*	*.2340*	*.2559*	*.2769*	....
.09	N	....	2.810	2.476	2.254	2.095	1.976	1.880	1.802	....
	Q	....	*.1412*	*.1671*	*.1913*	*.2142*	*.2362*	*.2580*	*.2789*	....

Using $f_c = 300 + (0.10 + 4p)\ f'_c$, $f_s > 18{,}000$ for all values of pn in this table. Therefore the actual tension in the steel should be investigated in each case.

Concrete outside of core is disregarded. D is the core diameter, in inches.

GENERAL FORMULAS

$$M_o = D^2\ Q\ f_c$$

$$W_s = D^2 \frac{\pi}{4}\ (pn + 1)$$

W_a = Actual load

Safe bending moment $= M_s =$

$$M_o \left[1 - \frac{W_a}{W_s} \left(\frac{\text{Axial stress}}{\text{Combined stress}}\right)\right]$$

tion that the steel is entirely outside the core. Greater accuracy would have resulted if the core diameter had been taken as the distance between centers of the steel bars comprising the longitudinal column reinforcement, but the method employed simplifies matters and is sufficiently accurate for practical purposes.

The derivation of the formulas will not be given, because of lack of space. However, for the benefit of designers who wish to check the work, it should be said that the first formula is derived from the usual concrete formulas. The formula for rectangular columns is derived by assuming the tension steel to be divided into two parts, one to balance the concrete and one to balance the compression steel. Two formulas are then set up for the value of f_s, equated, and solved for N. Then two formulas represent the moments due to the concrete and the compression steel, and their sum is the value of Q. The expression N is the deflection ratio of f_s divided by nf_c.

Formulas for Circular Columns

In deriving the formula for circular columns the longitudinal reinforcing bars were assumed to be concentrated in a ring. Next a formula was set up for the moment in an elementary section of width dx, from which it was found that p and N vary, as does f_c. By substituting their values in terms of x and y, an equation is obtained that can not be integrated, but by plotting out the curve for various values of pn it was found that the curve is almost an exact ellipse with axes equal to 0.935 R and $pn + 2k - \frac{2}{3}k^2$. Upon integrating this curve the constant 0.1836 is obtained.

TABLE 4

Coefficients for Radius of Gyration of Concrete Columns

SQUARE COLUMNS

Radius of gyration $r = dR$

Values of R

$$R = \sqrt{\frac{1 + pn}{12}}$$

pn	0.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	pn
0.1	.3028	.3042	.3056	.3070	.3083	.3096	.3109	.3123	.3136	.3149	0.1
0.2	.3162	.3175	.3188	.3201	.3214	.3227	.3240	.3253	.3266	.3279	0.2
0.3	.3291	.3304	.3317	.3330	.3343	.3355	.3368	.3381	.3394	.3407	0.3
0.4	.3419	.3431	.3442	.3453	.3464	.3476	.3488	.3499	.3510	.3521	0.4
0.5	.3533	.3545	.3557	.3569	.3581	.3593	.3605	.3617	.3629	.3641	0.5
0.6	.3652	....	....	....	....	....	....	....	....	....	....

For rectangular columns use least "*d*."

ROUND COLUMNS

$r = dR$

Values of R

$$R = \sqrt{\frac{1 + pn}{16}}$$

pn	0.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	pn
0.1	.2622	.2634	.2646	.2658	.2670	.2681	.2693	.2704	.2716	.2728	0.1
0.2	.2739	.2750	.2762	.2773	.2784	.2795	.2806	.2817	.2828	.2839	0.2
0.3	.2850	.2861	.2872	.2883	.2894	.2905	.2915	.2926	.2937	.2948	0.3
0.4	.2958	.2969	.2979	.2989	.3000	.3010	.3020	.3031	.3041	.3052	0.4
0.5	.3062	.3072	.3082	.3093	.3103	.3113	.3123	.3133	.3143	.3153	0.5
0.6	.3163	....	....	....	....	....	....	....	....	....	....

HOW TO DO IT

◆ **Questions and Answers** ◆
Consultation and Comment

A department devoted to the solution of problems encountered in concrete work. Readers are welcome to add to or improve upon the suggestions printed and to submit their views for possible publication.

Cracks in Concrete Water Tank Repaired With Gunite

We have been interested in reading your reply to R. E. B., of Wheeling, W. Va., on page 33 *of the May issue of* CONCRETE, *concerning his inquiry about the repair of vertical cracks in a water tank.*

May we take this opportunity to say that "gunite," the sand-and-cement product of the cement gun, will positively seal and make waterproof any type of reservoir or standpipe where we are able to get at the inside of the structure.—J. Q. A. Greene, vice-president, Gunite Concrete and Construction Co., Chicago, Ill.

Our reply to R. E. B., on page 33 of the May issue, would have been more complete if this well known material, gunite, had been mentioned along with "portland cement-and-sand mortar" as a suitable filler material in the repair of cracks.

While, to the layman, gunite is a cement-and-sand mortar in one sense of the term, the force by which it is applied produces a denser and stronger material than mortar applied by hand-placing methods.

Protecting Concrete Pipe While Awaiting Inspection

Some trouble has been reported from a South American city, lying in latitude 35 *deg. south, due to the cracking of machine-made concrete pipe of small diameter, used for house connections to sanitary sewers. One of the characteristics of the climate of this city is sudden changes in temperature, with wide variations during the day as well as great variations between maximum day temperatures and minimum night temperatures.*

The concrete pipe employed in making house connections are 4 *in. in inside diameter and* 30 *in. long, with a shell thickness of* ⅝ *in. The mixture used in their manufacture is a* 1:2½ *mixture of portland cement and sand. The joints are the bell type. The practice in laying the pipe is to place them in the ditch, cement the joints with a* 1:1 *mortar of portland cement and sand, after which the work is left to cure in the open air for several days, or until the city inspection department has inspected the work and has made tests for impermeability. Frequently, during this curing period, cracks perpendicular to the axis of the tile have formed midway between joints.*

A manufacturer of concrete pipe machinery has supplied readers of CONCRETE with both the cause and the cure for this difficulty. Similar trouble, he states, formerly was encountered in a Florida city where weather conditions are somewhat similar to conditions prevailing in the South American city. In the Florida city the sun often is very hot during the middle of the day. The former practice was to lay the pipe during the day and then to test them for impermeability by running water in them in the evening. The presence of the cold water employed in the test, coupled with the drop in the temperature of the air, often resulted in contraction of the pipe to the extent that they broke midway between joints, exactly as reported from the South American city.

The trouble was overcome by wetting the pipe with cold water before cementing the joints, and immediately covering them with dirt as the work proceeded. In this way the tile were cool when cemented and were kept relatively cool in the ditch line until the testing and inspection was made. The dirt covering, of course, greatly modifies the effect of the sun or of sudden changes in the temperature of the air.

The manufacturer suggests further that, when possible, it would be well to lay the pipe in the early morning or late evening, again covering them with several inches of dirt to protect the work from the hot mid-day sun.

Specifications for Concrete Burial Vaults

What is the present status of the standard specifications for concrete burial vaults, and where can I get a copy?—P. B. G., Branford, Conn.

Presumably the specification to which you refer is the tentative specification for concrete burial vaults, developed in recent years by committees representing the American Concrete Institute and the National Concrete Burial Vault Association.

Under the heading "Specification for Concrete Burial Vaults" the committee's report was published as a progress report in the June (1931) *Journal* of the American Concrete Institute, 641 New Center Building, Detroit, Mich.

However, at the last annual meeting of the American Concrete Institute the report was revised in several respects and was adopted as a tentative standard. In its revised form it is soon to be published in the *Journal* of the Institute.

This tentative standard can also be obtained from the Institute in separate leaflet form, at 10 cents for a single copy, at 5 cents each in lots of 100, or at 4 cents each in lots of 250 or more.

Hollow Concrete Poles and Piling

Where may equipment be obtained for the manufacture of hollow concrete poles for telephone and power lines, and for concrete piling? I refer in particular to poles manufactured by a centrifugal process.—T. A. M., Auckland, New Zealand.

Several American companies manufacture equipment for making poles of this character by a centrifugal process. A list of such companies is being forwarded to you.

New Books and Pamphlets

Concrete Tennis Courts

Present Status and Desirable Modifications of Tennis. By Paul Bennett, tennis coach, Northwestern University, Evanston, Ill. Published by the author. Paper cover, 24 pages, 6 by 9 in., diagrams and tables.

This bulletin contains the results of a survey of tennis facilities at 242 high schools in the central west. The report deals with a broad scope of subjects, including a statement of the wholly inadequate facilities now available, standard dimensions, construction and maintenance costs, and comparison of costs of different types of construction. Concrete tennis courts are recommended as unquestionably the most satisfactory type of construction.

The booklet will serve as a useful aid in the preparation of plans for concrete tennis courts, as well as in the promotion of better playing facilities at high schools not now provided with concrete courts.

Handling and Use of Explosives

Safety in the Handling and Use of Explosives. Published in January, 1932, by the Institute of Makers of Explosives, 103 Park Avenue, New York. Paper cover, 63 pages, 6 by 9 in. Illustrated with halftones and many line drawings.

The methods recommended in this useful and informative booklet are based on years of study and the combined experience of many men engaged in the use of explosives in practically every type of work. The fundamentals of approved safety practices, described by the text and illustrated with photographs and drawings, are intended to give a practical and comprehensive knowledge of the precautions to be observed.

Effect of Colloidal Clay

Weathering Resistance of Concrete, by E. J. Kilcawley. Published in March, 1932, as Bulletin No. 36, engineering and science series, by Rensselaer Polytechnic Institute, Troy, N. Y. Paper cover, 49 pages, 6 by 9 in., numerous tables and diagrams.

The four series of tests reported in this bulletin were made in an attempt to show the effect of certain portions of colloidal clay on the strength, permeability and weather resistance of concrete.

Each series included 40 specimens for compression tests and 32 for permeability tests, making a total of 288 specimens in the four series.

1932 Edition of Cement Directory

The American Cement Directory, 1932 Edition. Published by the Bradley Pulverizer Company, Allentown, Penna. Flexible cover, 83 pages, 3 by 4¾ in.

This twentieth edition, like former editions, contains two sections. The first is an alphabetical list of portland cement manufacturing companies in North and South America. Under the name of each company is a list of names and addresses of the principal officers, and the location of the company's plants. The second section comprises an alphabetical list of officers, superintendents, chemists and sales managers of cement companies in Canada and the United States.

ORGANIZATIONS

American Association of State Highway Officials; W. C. Markham, Executive Secretary, 1222-24 National Press Building. Washington, D. C.

American Concrete Institute; Harvey Whipple, Secretary, 641 New Center Building, Detroit, Mich.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 West Grand Ave., Chicago.

American Road Builders' Association; Chas. Upham, Engineer-Director, National Press Building, Washington, D. C.

American Society of Civil Engineers; Geo. T. Seabury, Secretary, 33 West Thirty-ninth St., New York City.

American Society for Testing Materials; C. L. Warwick, Secretary-Treasurer, 1315 Spruce St., Philadelphia, Pa.
Thirty-fifth annual meeting, June 20-24, Haddon Hall, Atlantic City, N. J.

Associated General Contractors of America; E. J. Harding, Managing Director, 222 Munsey Bldg., Washington, D. C.

Building Officials Conference of America; Col. John W. Oehmann, Secretary, 1253 Lawrence St., N. E., Washington, D. C.

Cast Stone Institute; L. A. Falco, Secretary, Chapel St. and Blatchley Ave., New Haven, Conn.

Cement Institute; Luther G. McConnell, General Manager, 11 East 44th St., New York City.

Concrete Masonry Association; Jack Franklin, Secretary, 7071 Plankinton Bldg., Milwaukee, Wis.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, 333 North Michigan Ave., Chicago.

Engineering Institute of Canada; 2050 Mansfield St., Montreal, Quebec.

Joint Committee on Standard Specifications for Concrete and Reinforced Concrete; F. R. McMillan, Secretary, 33 West Grand Ave., Chicago.

National Board of Fire Underwriters; W. E. Mallalieu, General Manager, 85 John St., New York City.

National Concrete Burial Vault Association; J. H. Stuart, Secretary-Treasurer, Bremen, Ohio.

National Crushed Stone Association; J. R. Boyd, Secretary, 1735 14th Street, N. W., Washington, D. C.

National Engineering Inspection Association; B. H. Witherspoon, Secretary, P. O. Box 1115, Pittsburgh, Pa.

National Fire Protection Association; Franklin H. Wentworth, Secretary, 40 Central St., Boston, Mass.

National Lime Association; Norman G. Hough, Secretary and Manager, 927 Fifteenth St., N. W., Washington, D. C.

National Ready-Mixed Concrete Association; V. P. Ahearn, Secretary, 545 Munsey Building, Washington, D. C.

National Sand and Gravel Association; V. P. Ahearn, Executive Secretary, 545 Munsey Bldg., Washington, D. C.

National Slag Association; H. J. Love, Secretary-Treasurer, 937 Leader Bldg., Cleveland, Ohio.

National Terrazzo and Mosaic Association; U. F. Durner, Secretary, 815 West St. Paul Ave., Milwaukee, Wis.

Northwest Concrete Products Association; W. P. Hews, Secretary-Treasurer, Yakima, Wash.

Portland Cement Association; Edward J. Mehren, President; William M. Kinney, General Manager, 33 West Grand Ave., Chicago.

Rail Steel Bar Association; H. P. Bigler, Engineering Secretary; Builders' Bldg., 228 N. La Salle St., Chicago, Ill.

Wire Reinforcement Institute; R. D. Bradbury, Director, National Press Bldg., Washington, D. C.

Wisconsin Concrete Products Association; Jack Franklin, Secretary-Treasurer, 425 East Water St., Milwaukee, Wis.

New Equipment and Materials

Materials Handling Equipment Line Added by Osborn

According to Franklin G. Smith, president, the Osborn Manufacturing Co., Cleveland, Ohio, has made an important addition to its wide range of manufacturing activities. A complete line of overhead materials handling equipment, to be known as Osborn tramrail systems, has been designed and built in the new materials handling division.

Osborn tramrail systems have been designed to meet practically every condition encountered in the installation of overhead materials handling equipment. There are several exclusive features of design in the equipment for safe and quick overhead transportation of materials, according to Mr. Smith. The equipment is built for capacities up to three tons.

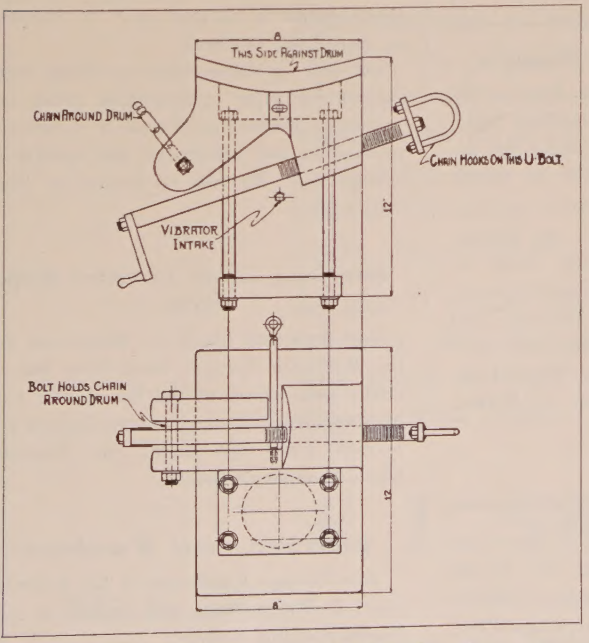
J. B. Forker, Jr., is sales manager of the division. He is also in charge of designing the equipment. R. W. Hisey, secretary of the company, is in charge of production.

Attachments Adapt Vibrator to Different Uses

Berkshire vibrators, a product of the Berkshire Manufacturing Co., Cleveland, Ohio, are manufactured for the vibration of concrete going into wall forms or columns, bridge decks, floors and arches, and concrete pipe. They are equipped with screw clamp or spud attachment, depending upon their use.

The vibrators are said to be operable by unskilled labor, having but two moving parts.

Specifications for the spud-equipped unit are as follows: Air pressure, 60 to 80 lb.; vibrations per minute, 2,500; approximate weight, 48 lbs.; air consumption per minute, 17 cu. ft.



Berkshire Vibrator, Type C 3PE, for Concrete Pipe

Autocar Develops Model R, New 1½-Ton Truck Having 6 Cylinders

The Model R, 1½-ton Autocar has been developed by the Autocar Co., Ardmore, Pa., in an effort to produce "an outstanding, powerful and long-lived truck at reasonable list price."

It is a 6-cylinder dual-rear-wheel truck with standard wheelbases of 159, 171, and 189 in. Its gross weight is 14,000 lb.

It is powered by a newly designed Autocar Blue Streak engine with 3¾-in. bore and 4¾-in. stroke. This gives a piston displacement of 314 cu. in., and the N. A. C. C. horsepower rating of 33.75. At its relatively low governed speed of 2,400 r.p.m. the engine yields 75 brake horsepower. It is said to be the largest 1½-ton engine listed by any manufacturer. The crankshaft rides on seven 3-inch main bearings with a total bearing length of 12¾ in.

Power application is through an Autocar 4-speed transmission with low ratio of 6.41 to 1 and a direct high gear. The standard rear axle has a 5.22 ratio, and is full-floating spiral bevel drive, also of Autocar manufacture.

At its governed speed the loaded truck is said to be good for 45 miles per hour and a grade of 4.8 per cent in high gear.

Model R is lavishly supplied with brakes. Four Lockheed internal-expanding shoes have a total of 388 square inches of lining.

Another strong feature, the manufacturers state, is its channel steel frame, with cross section measuring 6⅞ by 3 by 3/16 in.

Kalwax No. 18 Is Concrete Products Waterproofing

Kalwax No. 18 is a paraffine material newly added to the line of the Kalamazoo Paraffine Co., Kalamazoo, Mich., for waterproof treatment of concrete products and structures.

Kalwax No. 18 is described as a perfect, stable emulsion containing a high percentage of the regular Kalwax waterproofing paraffine in chemically and mechanically treated water. It may be applied exactly as it is, without preparation, dilution or heating, as a dip treatment, with a brush or better yet as a spray.

In appearance Kalwax No. 18 is a clean water-thin liquid. Like Kalwax Paraffine, Kalwax No. 18 is not a surface coating protection.

1932 Jaeger Truck Mixer on 1932 Ford Truck

A high speed truck mixer for both the contractor and the commercial concrete plant is offered in the 1932 Jaeger 1 and 1½ cu. yd. units mounted on the 1932 Ford chassis. The 1-yd. unit is furnished for 132-in. wheelbase and is driven direct from the truck engine. The 1½-yd. unit is furnished with separate engine drive for 157-in. wheelbase chassis.

With the speed of the new Ford, these truck mixer units are ideal for express service use by commercial concrete plants and for use by contractors on road widening and maintenance work, aprons, bridges, conduit, sewer, curb and gutter work.

Fairfield Makes New Portable Troughed Belt Conveyor

In line with present policies to build equipment that permits close economy in material handling, the Fairfield Engineering Company, Marion, Ohio, makes another addition to its representative line.

It is the new Fairfield portable troughed belt conveyor, built in lengths of 20, 25 and 30 ft.

It is primarily intended for the handling of sand, gravel, crushed stone and other abrasive materials by contractors and for handling materials for highway maintenance.

The new conveyor is said to be carefully designed, sturdily constructed, light in weight, easily moved, has ample capacity, and requires very little power to operate.

Forty-eight-in. carriage wheels mounted on roller bearings facilitate movement.

The conveyor belt is an 18-in. wide high-grade rubber belt. It runs over Fairfield ball bearing idlers. These idlers are closely spaced and are equipped with pressure lubrication fittings.

A steel plate receiving hopper at the foot end serves to center the load into the conveyor belt. The receiving hopper plates are equipped with replaceable rubber wear strips.

The conveyor is equipped with steel skirt plates for full length and which provide a carrying trough 6 in. deep.

The return belt is protected against falling materials by a steel plate formed in an inverted "V" shape and running full length.

To provide efficient traction an 8-in. diameter lagged head pulley is used.

A machined worm winch of the self-locking type mounted on side of conveyor frame permits operator to adjust conveyor discharge height readily at all times.

Power is furnished by 3-hp. ball bearing electric motor or 4½-hp. air-cooled gasoline engine.

About Makers of Equipment and Materials

Industrial Literature

Screeding and Finishing Equipment

A publication on finishing machines just issued by the *Jaeger Machine Co.*, Columbus, Ohio, is *Bulletin 47*, presenting "6 reasons why the Lakewood finisher does better work for less money on all types of concrete pavements."

Each feature, among them tiltable 12-in. screeds, four finishing combinations, and the flexibility, are described and illustrated. Also included in the publication are illustrations showing use of screeds and finishers on jobs, general assembly diagram and table, a description of the Lakewood 8-in. base road form, form tamper, graderooter, subgrader, batch boxes and cars, aluminum straight edge, and float bridges.

Southwark-Emery Testing Machines

Views and descriptions of the 4,000,000-lb., compression-only, machine of the U. S. Bureau of Reclamation, at Denver, Colo., now engaged in the testing of large concrete cylinders for Hoover dam concrete, are a part of *Bulletin* 28, published by the *Baldwin-Southwark Corp.*, Philadelphia, Pa.

Use of Gunite

Pictures comprise the bulk of a publication issued by the *Gunite Concrete and Construction Co.*, Chicago, Ill., and known as *"Cement Gun Shots."*

A great variety of gunited jobs, varying in size and type, are shown.

Construction Advantages of High Early Strength

A set of six 8 by 16-in. sheets, printed in large type on heavy enameled paper, has been issued by the Incor Division of the *International Cement Corporation*, New York City, in which the construction advantages of high-early-strength cement are stated concisely.

Elimination of detours, lengthening of the construction season to 12 months, high-early-strength cement and high-early-strength concrete as new construction materials, lessening business losses due to street obstruction, enlargement of market for building construction because of more speedy progress, are some of the advantages pointed out.

Flexcell Expansion Joints

Flexcell resilient expansion joints are described in a 4-page folder prepared by the *Flexcell Mfg. Co., Ltd.*, Modesto, Calif.

The joint is described as being elastic but not plastic and having a tensile strength of over 250 lb. to the sq. in. Flexcell is said to remain a clean line, with no tendency to mushrooming.

It is recommended for use in highways, bridges, viaducts, stadiums, retaining walls, sidewalks, pavements, monolithic roofs, floors, and platforms.

Manufacturers' News

Holder B-G Boston Manager

The Barber-Greene Co., of Aurora, Illinois, manufacturers of standardized material handling machinery, announce the appointment of *Walter B. Holder* as branch manager of their Boston office.

Mr. Holder has been with the Barber-Greene Company since 1926. Prior to coming with the company, he had 11 years' experience designing coal elevating and conveying machinery with the Underwood Machinery Company, and the Mead-Morisson Manufacturing Company, of Boston, and George P. Carver, Inc.

Compacted Concrete Pavements

All rights and privileges of the *Compacted Concrete* methods in the United States, its possessions and foreign countries are now held by *Compacted Concrete Pavements Engineers*, Minneapolis, Minn.

Offices are also established at St. Louis.

GarKem Products

The Gardner Laboratories, Inc., Chicago, Ill., has issued leaflets on several of its products giving general information and directions for use. These include standard specifications for *"Waterproofing Concrete by the Integral Method with Garkem Integral Waterproofing," "Rainproofing and Moistureproofing by the GarKem Colorless Method," "Oilproofing Concrete Tanks by the GarKem Enamel Method," "Floor Hardening and Dustproofing by the Oil Method with GarKem Concrete Dressing," "Floor Hardening and Dustproofing by the Acid Method with GarKem Crystal Hardener,"* and a GarKem Bulletin on the treatment of Concrete Floors to Prevent Dust and Increase Resistance to Wear.

A product on which there are no printed data is *Crackseal*, which is made with varying viscosity, elasticity and weight, to meet different types of conditions.

Freeman Joins P. T. L.

The Pittsburgh Testing Laboratory, Pittsburgh, Pa., during May, announced the addition to its staff of *P. J. Freeman* as consulting engineer.

He will specialize upon problems relating to municipal construction, roads and pavement, technological control of concrete production and placement, and special investigations. He will be located at Pittsburgh.

American Cable Licenses Rope Firm

The American Cable Co. announces that the *Wickwire Spencer Steel Corp.* has recently been added to the list of wire rope manufacturers licensed to manufacture preformed wire rope under the American Cable Company's patents.

American Steel Warehouse

The Chicago warehouse of the American Steel & Wire Co. is now located at 2364 South Ashland Avenue.

Its former location was 403 West Lake Street.